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The Convention

I HAVE been to a convention. Quite a number of engineers, holding, many of them, important positions, left their plants for several days, paid a goodly sum in railroad fares and hotel bills, heard some speeches, elected their officers for the ensuing year, had a picnic and went back to work.

In sacrifice of pay and of time, in traveling expenses, hall rent, entertainment and otherwise, a goodly sum of money was expended. Was the result worth it?

So far as anything that the meeting produced of record, No! The justification for the expenditure must be looked for in its inspirational effect upon the participants and in the perpetuation of the organization of which it was the annual gathering.

The man who goes to a convention simply to wear a badge and be a delegate may get his money's worth in preference and fun. The man who brings away the most is he who takes advantage of the broadening effect of contact with his fellow engineers, who increases the radius of his own experience, who extends his circle of acquaintances, forms friendships that will be enjoyable and beneficial, learns what is going on in other cities and other plants, and visits the exhibition of power-plant apparatus and supplies, usually held in connection with such conventions, on a real quest for knowledge of new things that may be useful in his plant.

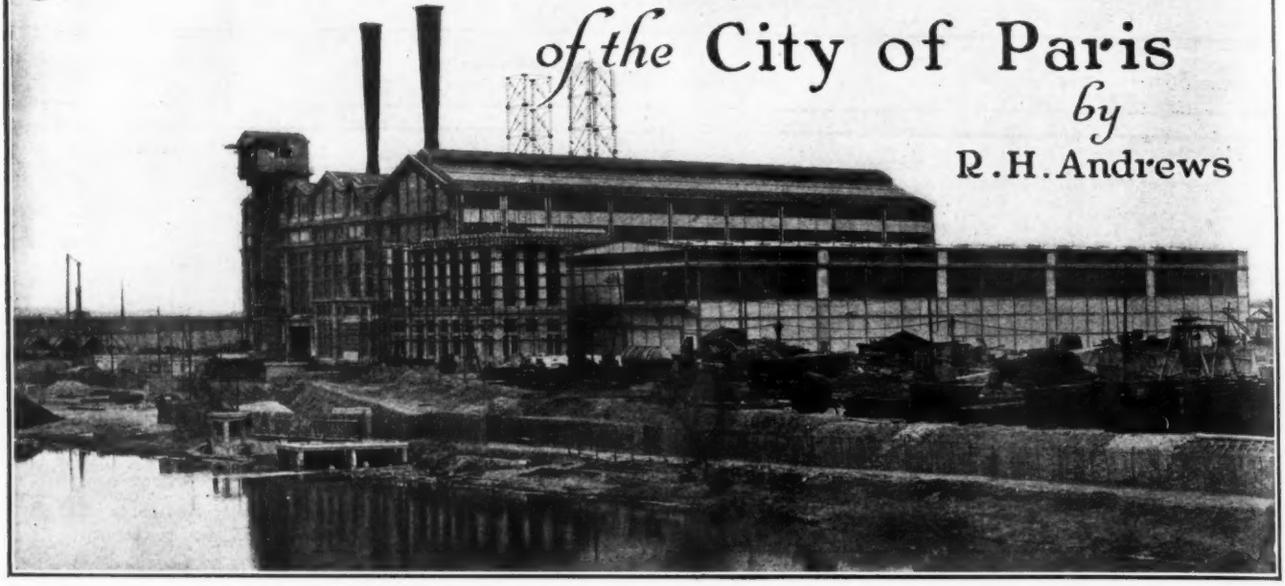
To such a man attendance at a convention will pay a dividend upon its cost, and in offering to such men the opportunity to represent it, the association furnishes an incentive for the devotion and interest that win such preferment and keep the association alive. The right kind of a delegate can also bring back to his association something of the inspiration and enthusiasm that he has absorbed, and in a way extend its broadening effect among the membership.

It is by such effects rather than by the resolutions that are passed that the ordinary convention must be judged and justified.

F. R. Low

The Gennevilliers Super-Power Station of the City of Paris

by R. H. Andrews



A GENERATING station of 320,000-kilowatts ultimate capacity, equipped for preheating of combustion air, for step-by-step feed water heating with steam bled from two successive stages of the turbine, and with a closed cooling circuit for the generators.

THERE is no better stimulant to progress in power-plant design than the high cost of coal, and it is natural that those countries that have had to face the greatest scarcity of fuels since the war should soon prove to be the leaders in the central-station field. It should therefore be no surprise to American engineers that the French, who in the past have been conspicuously conservative in their designs, have suddenly conceived a plant of exceptional interest, in several ways a pioneer installation that holds many a lesson for our designers.

After the armistice the electrical distribution and supply system of the City of Paris, strained by five years of continuous operation practically without repairs, was in urgent need of overhauling and renovating. The power consumption of Paris and its surroundings was expected to develop rapidly, and it was at once evident that the coal saved by a large up-to-date central station over the antiquated equipment of most of the existing plants, would in a few years pay the cost of the new plant. It was therefore decided to build a plant of sufficient capacity to supply the larger part of the present needs of the city, and gradually to shut down the older plants, as fast as the different generating units of the new one could be placed in service, retaining only the most modern existing stations to carry the peaks of the city's load.

The site chosen for the Gennevilliers[1] Station was a point about four miles from the city limits, as the crow flies, on the banks of the Seine, and alongside the main line from Paris to Havre—a perfect location. The plant is now about three-quarters completed. Two of the five 40,000-kw. units to be installed at once have been tested and are now ready to be connected to the city distribution system. Another is about to be tested and two are under construction. The capacity of the finished plant will be 200,000 kw. to be ultimately increased to 320,000 by the addition of three more units.

In designing this station, the foremost consideration was fuel economy. Though the cost of coal in France has greatly decreased since the 1920 peak, it still stands at about five times the pre-war level. Even if it should drop as low as 60 francs a ton—a most unlikely occurrence—a one per cent saving in the coal consumption of a 320,000-kw. plant would represent, at the present exchange rate, a yearly saving of about $45,000. This would warrant the expenditure of more than a quarter of a million dollars for the equipment necessary to secure this one per cent saving. With these figures in mind the designing engineers visited all the latest plants in England and America, consulted many power-plant experts, and finally laid down plans that show, in some details, the influence of American and British practice, but lead the way with many innovations.[2]

In order to secure a high fuel economy in plant operation, the following basic principles were adopted:

1. A high thermodynamic efficiency is obtained through high steam pressure and temperature.

[1] Pronounced *Zhen—vee—yay.*

[2] To power-plant engineers and designers, the writer recommends the book written by Col. E. Mercier, designer of the Gennevilliers station, describing the plant. Aside from a number of cuts showing design details, the book contains five large inserts, giving different cross-sections and plans of the station and of the coal-handling equipment. In view of the several innovations presented in this station and of the careful design evident throughout the plant, the drawings and descriptive matter should prove of real value to American engineers and students. The book is being printed in English and will shortly be available by applying to the "Union d'Electricité," Consulting Engineers, or to the "Revue Industrielle," both at 57 rue Pierre-Charron, Paris. The price will be $1.25.

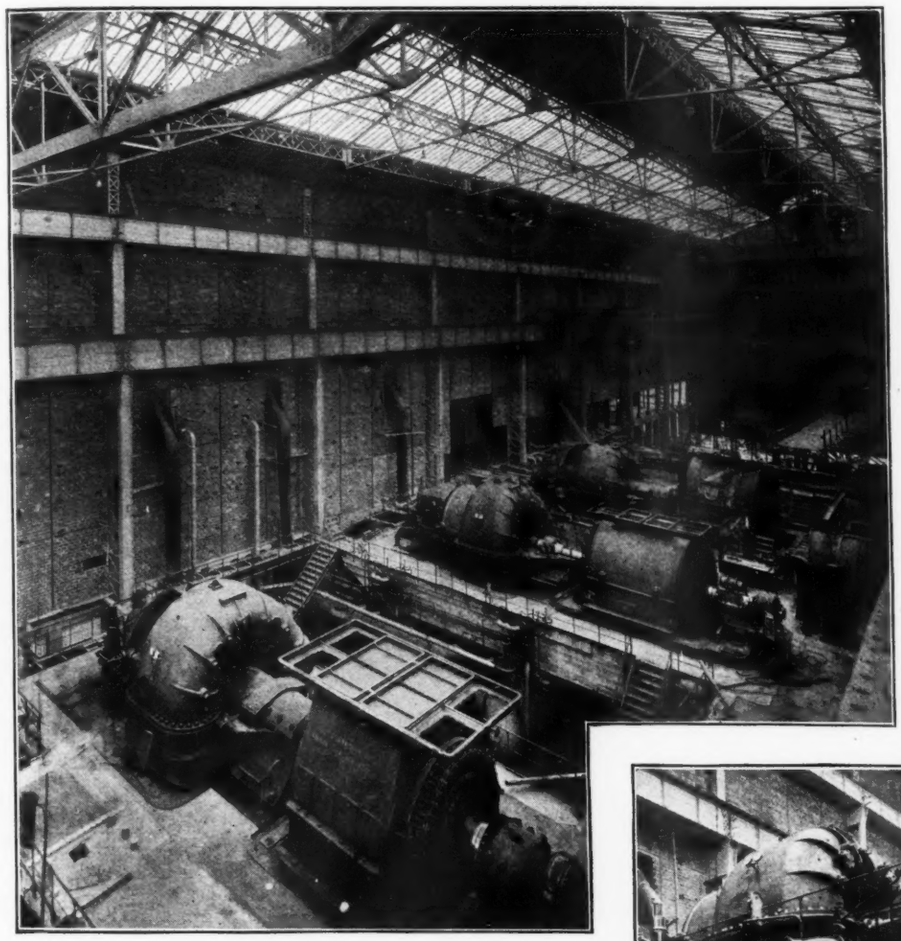


Fig. 1. General view of the turbine room during construction, showing three of the five generating units of the present installation. The ultimate plant will contain eight of these Zoelly-type, ten-stage units, each having a continuous full-load capacity of 40,000 kw. and a two-hour overload capacity of 45,000 kw. With steam at 313 lb. gage pressure and 280 deg. F. superheat, and an exhaust pressure of one inch of mercury, these units use only 9.46 lb. of steam per kilowatt-hour at their most economical load (30,000 kw.). The main supply of heat for the feed water is steam bled from the seventh and eighth stages. Running at 1,500 r.p.m., the generators supply 50-cycle three-phase current at a terminal voltage of 6,000.

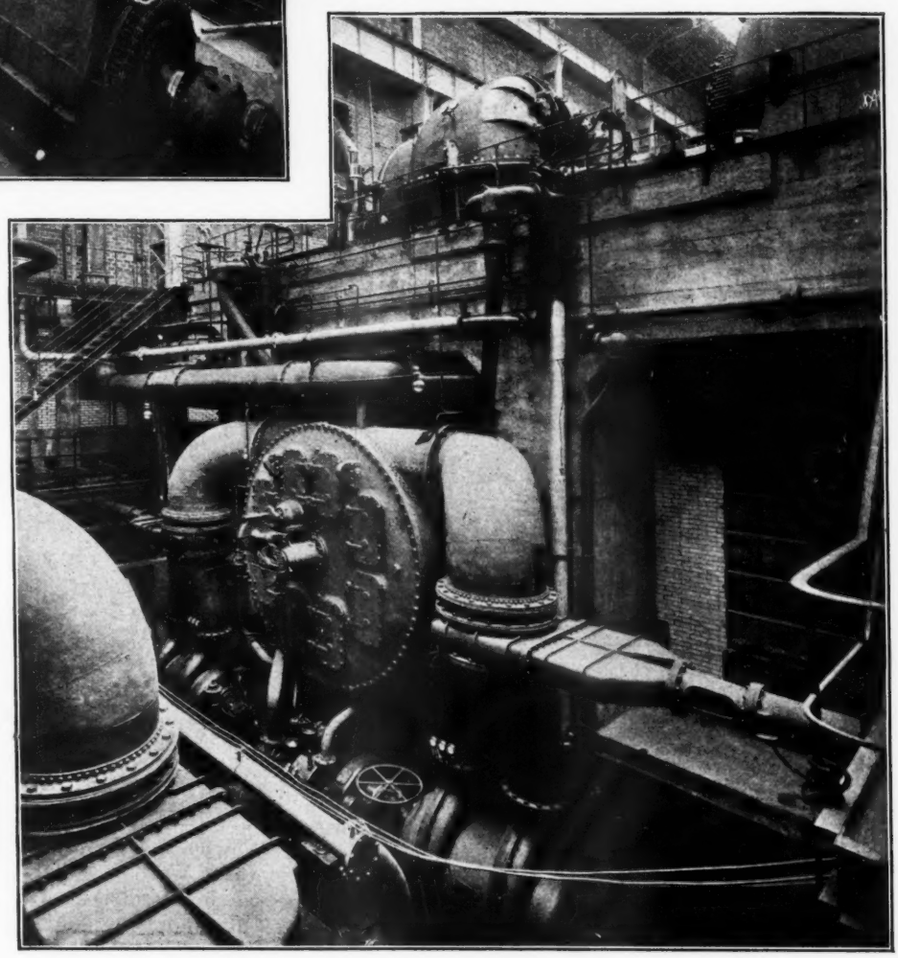


Fig. 2. View of the main condensers and the generator-air coolers. Each turbine exhausts into a 37,650-sq.ft. surface condenser whose tubes have an internal diameter of 0.787 in. and an external diameter of 0.866 in. The normal back pressure is around one inch of mercury. The condenser has two 30,000 gal. per min. circulating pumps, one electrically driven and the other (a spare unit) with duplex drive. There are two electrically driven, 720 gal. per min. condensate pumps, of which one is a spare, and four air ejectors (two spares). On the right can be seen part of the air cooler which permits the generator cooling air to give up its heat to the feed water.

2. A high efficiency in steam production is obtained by the use of large boilers equipped with the latest boiler-control devices, with high-pressure economizers and air preheaters.

3. A high efficiency in steam utilization is obtained by means of large generating units equipped to heat the feed water with steam bled from two of the lower stages.

4. To recover practically all the electrical and mechanical losses in the generators, both the generator and the bearings are indirectly cooled by the condensate from the turbine, the heat being in this way returned to the boiler.

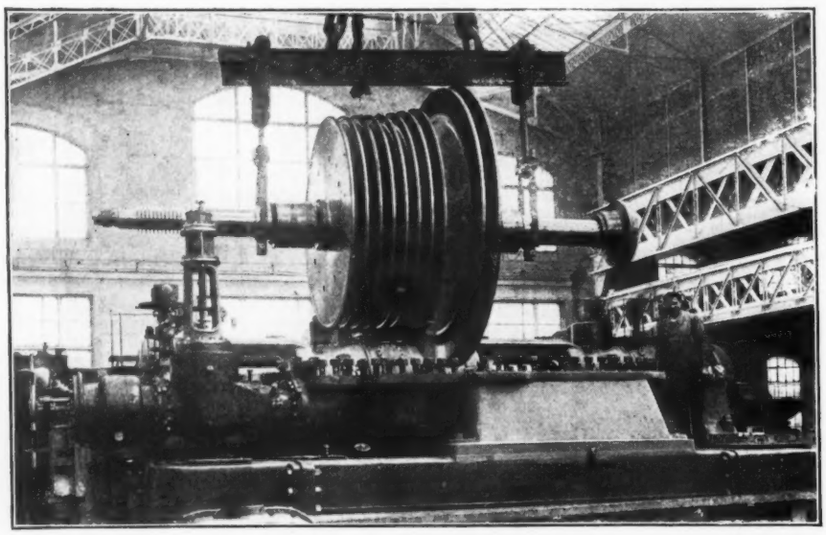


FIG. 3—UNIT NO. 1 BEING ASSEMBLED FOR TEST AT THE FACTORY
Note the small number of stages and the compact construction

TABLE I—BOILER-ROOM EQUIPMENT

	Double-ended Stirling	Single-ended B. & W.	Total
Number of boilers to be installed at once	5	10	15
Ultimate number of boilers, various possibilities	11	10	21
	8	16	24
	5	22	27
Maximum allowable steam pressure, lb. per sq.in.			355
Maximum total steam temperature, deg. F.			752

TABLE II—BOILERS AND FURNACES

Boiler Dimensions and Characteristics

	Stirling	Babcock & Wilcox
Heating surface per boiler, sq.ft.	22,600	14,300
Superheater surface, sq.ft.	10,764	8,190
Economizer surface, sq.ft.	12,915	8,617
Air-preheater surface, sq.ft.	19,350	12,060
Over-all dimensions:		
Width of face	34 ft., 10 in.	35 ft., 11 in.
Length	37 ft., 9 in.	20 ft., 3 in.
Height from boiler-room floor to C.L. of highest steam drum	28 ft., 7 in.	21 ft., 3 in
Volume of water at normal water level, cu.ft.	2,860	1,288
Volume of steam at normal water level, cu.ft.	705	583
Ratio volume of water to volume of steam	4.05	2.21
Volume of water per sq.ft. of heating surface, cu.ft.	0.127	0.09
Steam guarantees:		
Normal steaming rate, lb. per hour	132,000	88,000
Lb. per hour per sq.ft. heating sur.	5.85	6.15
Maximum two-hour rate, lb. per hour	176,000	116,000
Lb. per hr. pr sq.ft. heating surface	7.79	8.12

Grate Characteristics

Stirling boilers: Riley underfeed 36-retort mechanical stoker, in two sections of 18 retorts each, fed from two firing aisles, and discharging the ash in the center.
Total grate surface, per boiler, 660 sq.ft.
Babcock and Wilcox boilers: B. & W. chain-grate stokers, in four sections, each 15 feet long by 6 ft. 7 in. wide, equipped for forced draft.
Total grate surface, per boiler, 394 sq.ft.

Steam Pressure and Temperature

The Gennevilliers plant is conservative in the matter of steam pressure and temperature. A pressure of 313 lb. gage with a total temperature of 705 deg. F. (about 280 deg. superheat) at the throttle were the values chosen, whereas there is a plant under construction in England for a boiler pressure of 450 lb. gage. It is claimed, however, by the designers of Gennevilliers that the ratio of the thermal efficiency of the impulse turbine to that of the Rankine Cycle decreases under steam pressures higher than 350 lb. to such an extent as practically to offset the gain due to the higher cycle efficiency.

The Gennevilliers plant is one of the cheapest ever built in France. In spite of the great increase in building costs since the war this station will have cost no more per kilowatt installed, when completed, than the average of the plants built around Paris before the war. One of the reasons for this economy lies in the compactness of the boiler room, whose floor space per kilowatt installed—0.24 sq.ft.—is between one-third and one-quarter of the boiler-room floor space of the other Parisian plants. This is one of the advantages of large boilers.

The arrangement of the boiler room may be seen in the insert accompanying this article. It consists of three rows of boilers grouped in two "blocks," with three firing aisles. One of these blocks is made up of a single row of large double-ended Stirling-type boilers, of 22,600 sq.ft. of heating surface, fired from both ends. The other block is composed of two rows of

TABLE III—CHARACTERISTICS OF THE DRAFT EQUIPMENT AND COMBUSTION GUARANTEES

A. Stacks:
Number and type of stacks: 6 convergent-divergent, Prat type.
3 stacks serving the Stirling boilers, 3 the B & W.
1 stack for 2 Stirling or 4 B & W.

Stack dimensions:	Stirling Boilers	B & W Boilers
Height (Total)	121 feet	121 feet
Base (rectangular)	13 ft., 9 in. x 12 ft., 4 in.	15 ft., 1 in. x 13 ft., 9 in
Throat, diameter	6 ft., 3 in.	7 ft., 3 in.

B. Induced-draft fans:
Number of fans per stack: 2
Drive: Direct-current, adjustable-speed motors
Rated capacity of motors: On Stirling boiler stacks ..... 120 hp
On B & W boiler stacks ..... 150 hp

Guarantees:
Assuming:
Lower heating value of coal, 12,600 B.t.u. per pound
Temperature of outside air, 61 deg. F.
Barometric pressure, Standard.
Temperature of gases entering the induced-draft fans, 284 deg. F.
CO_2 content of gases entering the induced-draft fans, 11 per cent.
Forced-draft fans operating at their normal rate.

	Stirling-boiler Stack Serving 2 Boilers, or 1,320 Sq.Ft. of Grate			B & W-boiler Stack Serving 4 Boilers or 1,576 Sq.Ft. of Grate		
Draft at base of stack:	Natural	0.9 in.	1.97 in.	Natural	0.9 in.	1.97 in.
Combustion rate:						
Lbs. per hour	23,100	31,900	46,200	30,400	41,400	60,700
Lbs. per hour per sq.ft. of grate	17.5	24.2	35	19.3	26.3	38.5
Speed of fans, r.p.m.						
No. 1	0	335	430	0	305	385
No. 2	0	0	430	0	0	385
Power consumption of fans:						
Horsepower, No. 1	0	44	88	0	55	110
No. 2	0	0	88	0	0	110

Under the foregoing conditions, but with the forced-draft fans shut down, the induced-draft equipment alone will supply a draft of 2.36 in. with the expenditure of 170 hp. on each of the B & W stack motors, and 132 hp. on each of the Stirling stack motors.

C. Forced-draft fans:

	Stirling Boiler			B & W Boiler		
Number of fans per boiler	4			2		
Drive	Direct-current			Adjustable-speed motors		
Rated capacity of motors	60 hp.			80 hp.		
Fan characteristics:	Output Cu.Ft. per hr.	Power cons'n Hp.	Speed r.p.m.	Output Cu.Ft. per hr.	Power cons'n Hp.	Speed r.p.m.
Normal rate—5.9 in. draft.	1,760,000	43	870	2,380,000	58	745
Overload —7.1 in. draft.	1,980,000	60	955	2,650,000	80	820

Gennevilli

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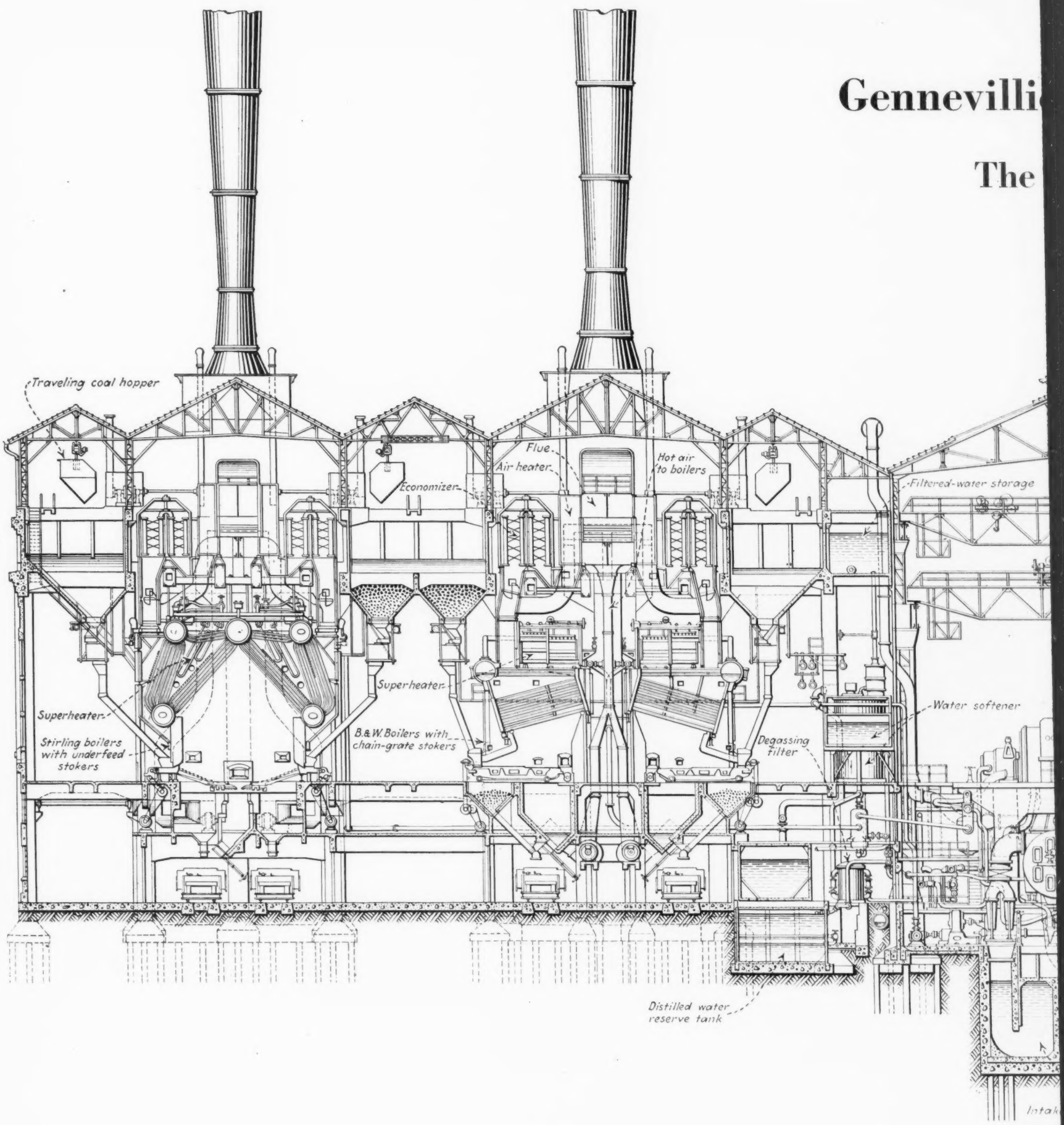
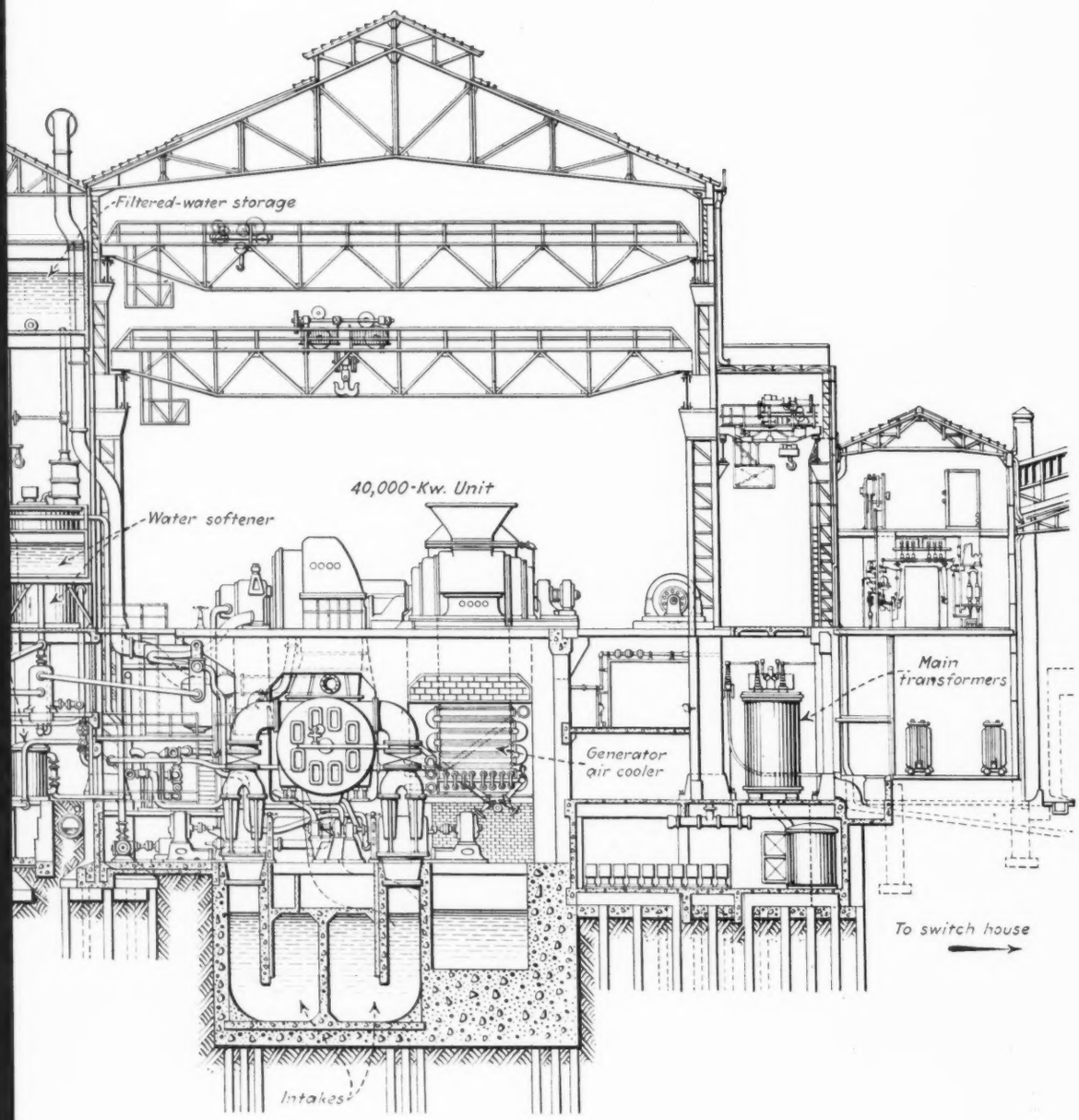


Gennevilliers Power Station
of
The City of Paris



Babcock & Wilcox marine-type boilers, set back to back, with a common flue in the center. The reasons for installing the two types of boilers are based rather on the respective characteristics of the stokers than on those of the boilers themselves. The Stirling boilers are equipped with Riley underfeed stokers, and the Babcock & Wilcox with the chain-grate type. The prevailing opinion among French engineers is that the latter is better fitted to handle a wide range of fuels, while the underfeed is considerably more flexible in its operation and better able to follow the fluctuations of the load. With the uncertainty of conditions in the fuel markets of Europe a large plant must be equipped to use any quality of coal it can get, and chain-grate stokers were therefore chosen. On the other hand, flexibility in operation is equally essential, to meet the kind of load this plant will have to carry; so underfeed stokers were also installed. Tables I and II give the number and characteristics of the boiler-room equipment.

TABLE IV.—TURBINE-ROOM EQUIPMENT CHARACTERISTICS

Number of Generating Units:	
In present plant	5
Ultimate number of units	8
Capacity of Generating Units at 80 per cent Power Factor:	
Most efficient load, kw	30,000
Full load (Maximum continuous), kw	40,000
Maximum overload (2 hours), kw	45,000

Builders:
3 complete sets built by Societe Alsacienne de Constructions Mecaniques; Belfort.
1 complete set built by Schneider & Cie.
1 turbine built by Escher Wyss & Cie., Zurich, Switzerland.
1 generator built by Schneider & Cie.
All the units are practically identical, and the rotors are interchangeable.

Characteristics of the Units:	
Speed, r.p.m.	1,500
Frequency, cycles	50
Terminal voltage	6,000
Throttle pressure, lb.	313
Total steam temperature, deg. F.	705

Type of Turbines: Simple impulse Zoelly type, straight single-flow, with 10 pressure stages, each consisting of one velocity stage. Two bleeder connections, one from 7th and one from 8th stages, by which steam is extracted for feed-water heating.
Mean diameter of first 7 wheels, 6 ft., 6¾ in.
Mean diameter of last 3 wheels, 9 ft., 2 in.
Length of blades of last stage, 22½ in.
Lubricating-oil pressure, 10.7 lb. per sq.in.
Oil pressure for valve operation, 55 to 70 lb. per sq.in.
Capacity of lubricating-oil pump, 400 gal. per min.
Turbine regulation, throttling.

The feature of prime interest in the boiler room is the heating of the combustion air before it goes to the furnace. It will be seen below that, owing to the special provisions for heating the feed water, the latter is fed to the economizer practically at 212 deg. F. In order to cool the flue gases more than would be possible with water at this temperature without installing an abnormally large economizer, an air preheater is added. Under normal load the hot gases, leaving the boiler at a temperature of about 620 deg. F., first pass through the high-pressure steel-tube economizer, which they leave at about 430 deg. They then pass through the air preheater, where their temperature is lowered to approximately 300 deg., while the air enters the heater at about 85 deg. and leaves it at 195 deg. to go to the furnace. The heater is composed of channel-iron frames and No. 7 gage steel plates, forming passages through which the air and the flue gas travel in alternate layers only 1⅜ in. thick. The air is taken from the top of the boiler room, where it has become heated to a certain extent, and travels downward through the heater, while the hot gases travel upward.

The interesting point about the construction of the heater is the fact that the plates are in standard commercial sizes and may be replaced without drilling, punching or machining of any kind, the whole structure being clamped together by means of long tension bolts.[3]

After leaving the heater, the air is collected in a hot-air box over the boiler, whence it is carried by the suction ducts to the forced-draft fans. The Stirling boilers, having two flues apiece, have two air preheaters and two economizers. Each Babcock & Wilcox boiler has one preheater and one economizer. The peculiar arrangement of the economizer—in two passes like an overturned *U*—makes it easy to bypass it when the boiler is being started up or shut down, in order to avoid condensation of the water vapor in the relatively cold flue gases and consequent corrosion of the tubes.

The two Babcock & Wilcox units, set back to back, occupy approximately the same over-all length as one Stirling unit. This makes it possible, in future extensions of the boiler room, to install either type or both, as may be desirable, without changing the structural details of the boiler house.

All the boilers are equipped with automatic feed-water and damper regulators, and the speed of the forced- and induced-draft fans is also automatically adjusted to the load. It is not as yet possible to describe the instruments for boiler control, for a few boilers have been equipped with several types of steam- and water-flow meters, *CO* and CO_2 meters, in order to test their relative values. The most satisfactory instruments will be installed in the rest of the plant.

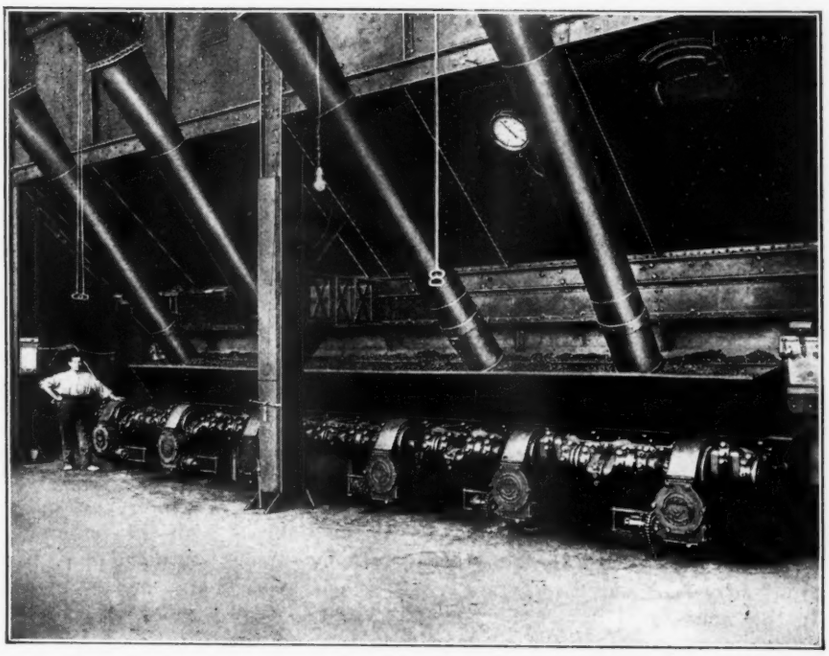


FIG. 4—EIGHTEEN-RETORT RILEY STOKER UNDER 22.60 -SQ.FT. STIRLING BOILER
Each Stirling boiler has two eighteen-retort stokers, one on each firing aisle

[3] A similar preheater was described in the April 18, 1922, issue of *Power*.

One of the striking features of the general aspect of this station is the shape of the stacks. The short convergent-divergent stack is now very generally used in Europe, in connection with the Prat induced-draft system. This type of stack, which is also known by the names "evase" and "Venturi," is said to require a much smaller amount of steel plate than a cylindrical stack giving the same draft. With this system most of the flue gas passes directly to the stack, but some of it is bypassed through a small fan whose discharge pipe passes again into the stack. The end of this discharge pipe is concentric with the stack and located a little below its smallest diameter. It is evident that the small amount of high-velocity gas passing up through the central orifice has an ejector effect and "induces" a draft in addition to that which the stack alone would produce.

The present plant will have six stacks, three serving the Stirling boilers—two boilers per stack—and

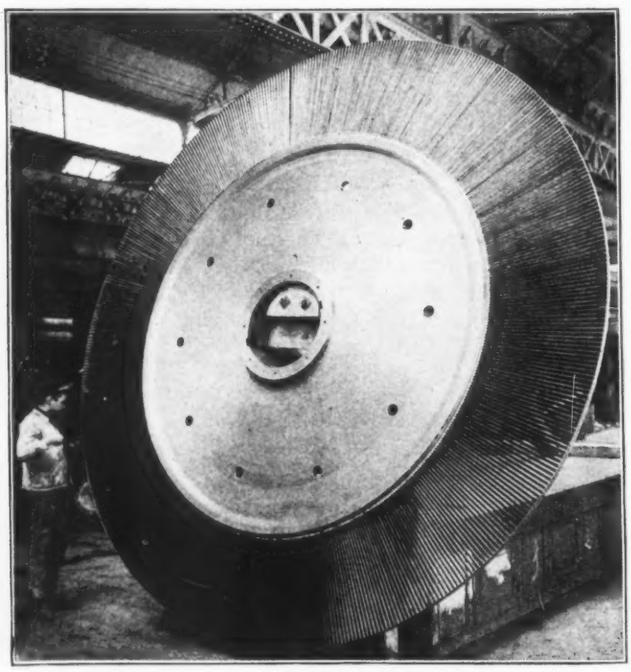


FIG. 5—THE LAST WHEEL OF ONE OF THE TURBINES
The mean diameter (at the center of the blades) is 9 ft. 2 in., and the blades are 22½ in. long.

three the Babcock & Wilcox—four boilers per stack. Each stack will have two induced-draft fans, and the boilers themselves will have forced-draft fans (four for each of the Stirling, two for each of the Babcock & Wilcox boilers). All the fans are driven by direct-current adjustable-speed motors.

In this connection it is not without interest to compare the arrangement of this plant with that of the Colfax and Delaware stations in America. Colfax has one forced-draft fan serving four boilers, or 83,000 sq.ft. of heating surface, and no induced-draft fans. Delaware has one forced-draft fan per boiler, serving 15,000 sq.ft. of surface, and two induced-draft fans per boiler. Gennevilliers has four forced-draft fans serving each of the large boilers, or one fan for 5,650 sq.ft., and one induced-draft fan for each of the same boilers.

The characteristics of the draft equipment and the combustion guarantees are given in Table III. Though these guarantees do not cover the higher combustion rates, the overload capacity of the draft equipment must be considerable. The highest combustion figures given in the table are for a total draft of 5.9 in. plus 2 in., or 7.9 in., whereas the maximum draft guaranteed is 7.1 plus 2.36, or nearly 9.5 in.

Coal-Handling Equipment

The coal-handling equipment presents several unusual features. Coal may be received by rail or by water, and the coal yard lies along the waterfront between the station and the river. Its storage capacity is 60,000 tons. The yard level is depressed about 10 ft., so that the bottom of the coal pile may be flooded to that depth. Two traveling cranes bridge the yard, and coal may be taken either from barges or from railroad cars, and delivered either to the coal yard or to 20-ton motor-driven cars, by means of a belt conveyor running through the center of each of the bridge cranes. The 20-ton cars, running on a standard-gage track, in turn dump the coal into pits opposite the boiler plant, from the bottom of which it is taken by duplicate bucket conveyors that lift it to the crusher. From the crusher the coal is raised to the top of the boiler house.

Up to this point there is nothing unusual in the coal-handling mechanism. The bridge cranes in the yard recall those of the Dalmarnock station in Glasgow, and the rest of the apparatus is more or less standard.

TABLE V.—PERFORMANCE OF THE GENERATING UNITS OF FIVE CENTRAL STATIONS

	Steam Condition at Throttle			Capacity of Turbine		Steam Consumption
	Gage Press. Lb.	Total Temperature Deg. F.	Superheat Deg. F.	Full Load, Kw.	Most Efficient Load, Kw.	Lb. per Kw.-hr.
Colfax	265	585	175	60,000	50,000	10.58
Delaware	235	576	175	30,000	22,000	10.8
Hell Gate (35,000 kw. units)	250	607	200	35,000	27,500	10.3
Dalmarnock	265	685	274	15,000	15,000	10.2
Gennevilliers	313	705	280	40,000	30,000	9.46

TABLE VI.—GUARANTEED STEAM CONSUMPTION OF GENNEVILLIERS TURBINES WITHOUT BLEEDING

Load Kilowatts	Consumption Lb. per Kw.-Hr.
40,000	9.62
30,000	9.46
20,000	9.9
10,000	11.0

But the method of distribution of the coal to the bunkers over the boilers is thought to be an innovation. The distribution is accomplished by several motor-driven traveling hoppers of about 6 tons capacity, which run on an overhead monorail system serving all the boilers. The track layout is so designed that any one bunker may be reached by four different routes, by means of suitable switching facilities. Furthermore, a complete interlocking block-signal system is installed. The track is divided into 150-ft. lengths, and any car traveling on one section automatically cuts off the power from the preceding block. Each individual car has two motors and takes its power from a trolley wire. The energy is 500-volt direct current. Each boiler bunker is fitted with an electro-magnet, which, when energized, trips the lock on the dumping door of the car as it passes and empties it into the bunker.

It is too early to venture an opinion on the value of this system. That it will prove more flexible than the bucket or belt conveyor is probable. That it may

be cheaper in first cost is also possible. But it is not so certain that it will not prove more complicated in its operation and require considerable care.

Steam Piping and Feed-Water Treatment

The steam piping is interesting principally as an example of one of the advantages of high steam pressures. The turbine mains have a diameter of 10 in. and steam velocities at full load reach nearly 12,000 ft. per min. All steam piping has welded steel flanges.

In the Gennevilliers station, as in the Dalmarnock plant in Glasgow, the water-softening process has been

TABLE VII.—CONDENSING-EQUIPMENT CHARACTERISTICS

The main condensers are identical for all units, all single-pass.		
Condensing surface, 37,650 sq.ft. 0.94 sq.ft. per kw.		
Diameter of tubes:	Inside, in.	0.787
	Outside, in.	0.866
Circulating pumps:	2 per unit, one being a spare;	
	Capacity 30,000 gal. per min.	
	Type, single-stage centrifugal.	
	Drive: Electric for regular service; duplex (electric and steam turbine with reduction gears) for the spare.	
Condensate pumps:	2 per condenser, one being a spare;	
	Capacity, 720 gal. per min.	
	Type, 2-stage centrifugal;	
	Drive, electric for both sets.	
Air extraction:	4 ejectors per condenser, 2 being spares.	
	Rated output at 225 lb. steam pressure.	

preferred to distillation. The arrangement is ingenious. After the makeup water has been treated, instead of going directly to the condensate tank and so being mixed with the condensate and evenly distributed among all the boilers, it goes to one of two boilers, which may be called the "distilling" boilers, for they are specifically reserved for the use of makeup water. One of these serves as a stand-by. The other boilers receive only distilled water from the main condensers and should therefore require no more attention than if evaporators were used; but the two distilling boilers may require frequent inspection and cleaning.

Continuous Process of Water Softening

The softening process, Kestner patent, is particularly interesting and economical, both in heat and reagent consumption. The basis is the Cochrane hot-soda process, adding carbonate of soda to the makeup water, to convert the sulphate and bicarbonate of lime carried by this water, into sulphate and bicarbonate of soda, both soluble and non-scale-forming salts. But instead of blowing the boiler down periodically, so as to keep down the concentration of the salts, and letting the water go to waste, a certain amount is drawn continuously from the bottom of the mud drums of the distilling boilers and piped back to the purifier to be mixed with the makeup. This has the double advantage of using the heat in this waste to heat the makeup, and accelerate the chemical reactions, and of making the chemical process partly regenerative; for in the course of this treatment carbonate of soda—that is, the salt added in the first place—is formed in the boiler and carried back to the purifier to serve over again.[4] Only enough reagent need be added to treat the sulphate in the makeup; that is, with most natural waters, less than 10 per cent of the amount needed to treat the bicarbonates.

If the manufacturer's claims are substantiated, it should be possible by the Kestner process to treat Seine water as makeup for the whole plant—200,000 kw.—with a consumption of less than 20 lb. of soda per day. An additional advantage in favor of the system was, under the existing conditions, that the softening apparatus was considerably cheaper than the evaporator equipment, both in itself and in the necessary piping.

Before going to the boiler-feed pumps, both the boiler makeup and the condensate from the turbine condensers pass through special degassing filters, filled with finely divided iron. This metal removes the last traces of dissolved oxygen, and it is expected that this process will entirely eliminate internal corrosion of the economizer and boiler tubes.

Zoelly Turbines of Simple Construction but High Efficiency

The first thing that will strike American turbine engineers about the Gennevilliers turbines is the small number of stages. They are of the straight Zoelly impulse type, in one cylinder, single-flow throughout, and have only ten pressure stages, each consisting of one velocity stage. Considering that the impulse turbines of the Delaware plant, operating under 235 lb. at the throttle, have 17 stages; that those of the Hell Gate station, operating under 250 lb. at the throttle, have 20 stages, it might have been expected that the Gennevilliers turbines, operating under 313 lb. would

TABLE VIII.—SUMMARY OF DESIGN CONSTANTS OF GENNEVILLIERS STATION

Steam conditions at Throttle:			
1.	Pressure, pounds gage		313
2.	Total temperature, deg. F.		705
3.	Deg. of superheat, deg. F.		280
Boiler room:			
4.	Sq.ft. of boiler heating surface per kilowatt station capacity		1.28
		Stirling	Babcock & Wilcox
5.	Sq.ft. of heating surface per sq.ft. of grate	34.3	36.3
6.	Cu.ft. of combustion space per sq.ft. of grate	2.08	7.8
7.	Sq.ft. of superheater surface per sq.ft. of heating surface	0.476	0.573
8.	Sq.ft. of economizer surface per sq.ft. of heating surface	0.572	0.602
9.	Sq.ft. of air-preheating surface per sq.ft. of heating surface	0.857	0.844
10.	Cu.ft. of water per cu.ft. of steam in boilers	3.24	2.21
11.	Cu.ft. of water in boilers per sq.ft. of heating surface	0.127	0.090
12.	Forced-draft fan-motor output per sq.ft. grate; horsepower; Normal rate of firing	0.261	0.294
	2-hour overload	0.364	0.406
13.	Induced-draft fan-motor output per sq.ft. grate, horsepower: Normal rate of firing	0.033	0.035
	2-hour overload	0.133	0.140
Turbine room:			
14.	Sq.ft. of condensing surface per kilowatt capacity		.941
15.	Ratio of circulating-pump capacity to condensate-pump capacity		42

have about 24 stages instead of 10. That this small number of stages has not been attained at the expense of efficiency may be seen from Tables V and VI.

The most important point about these turbines is not the number of stages, but the provisions for bleeding steam from the seventh and eighth stages for feed-water heating. Steam taken from the turbine in this way is led to two closed heaters, which are simply small surface condensers in which the cooling water is the condensate from the main condenser. This will be further discussed in connection with the heat-balance control of the plant.

The turbines operate at 1,500 r.p.m.; their most efficient load is 30,000 kw., the continuous full load

[4] The chemical reactions are as follows:
In the purifier, when the plant is first started up, the treatment of the bicarbonates is:

$$Ca(HCO_3)_2 + Na_2CO_3 = 2NaHCO_3 + CaCO_3$$

Bicarbonate of lime + Carbonate of soda = Bicarbonate of soda + Carbonate of lime.

For the magnesium bicarbonate the reactions are identical. The calcium and magnesium carbonates are precipitated and filtered out, and the makeup goes to the boiler with sodium bicarbonate in solution. In the boiler this salt breaks down into free CO_2, water and carbonate of soda, the latter returning to the purifier in the waste, to serve over again.

$$2NaHCO_3 = CO_2 + H_2O + Na_2CO_3$$

After the process has been started up, practically no soda need be added to *treat the bicarbonates*. The calcium sulphate must be treated continuously, however, for the reactions are not regenerative.

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

A small amount of water is wasted from the purifier to keep down the concentration of sodium sulphate in the boiler.

40,000 kw., and maximum overload 45,000 kw. They are controlled by two automatic admission valves and two bypass valves, the latter admitting high-pressure steam into the second stage above 30,000 kw. These valves are oil-operated and controlled by the governor, and their action is throttling.

Details of Condenser Equipment

The turbines exhaust into 37,650-sq.ft. surface condensers of the single-pass type. These condensers are rigidly connected to the turbine exhaust casing and are spring supported. Each condenser has two motor-driven condensate pumps and three air ejectors, one of each being a spare. Inasmuch as the ejectors give their rated output under 225 lb. steam pressure, and as a pressure of 313 lb. is available, there is probably about 100 per cent overload capacity in this equipment. Only part of the heat in the steam used by the ejectors can be recovered, for it is necessary to allow some of it to escape, in order to avoid carrying an excessive amount of air into the condensate tank.

Two circulating pumps are provided for each condenser, one motor-driven, for normal operation, and one equipped with duplex drive—steam turbine and electric motor—as a stand-by. With the exception that the turbine drives the pump through reduction gears, this arrangement recalls that of the circulating pumps of the Delaware plant. There is no similarity, however, in the use of the equipment in the two stations; for the turbine drive in Gennevilliers is to be used only as a last resort, in case of failure of the electric drive, whereas in the Delaware station it is run continuously in normal operation for the purpose of heat-balance control.

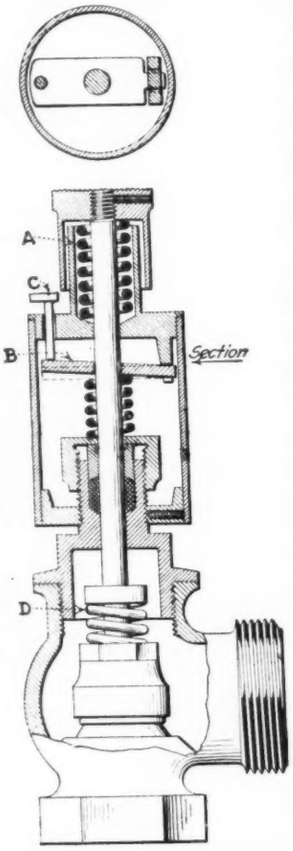
Relatively Small Condensing Surface

An interesting feature is the small amount of condensing surface per kilowatt of rated output. While both the Colfax and Delaware stations have 1.67 sq.ft. of condensing surface per kilowatt and Dalmarnock has 1.73 sq.ft., Gennevilliers has only 0.94 sq.ft. per kilowatt, or nearly 44 per cent less than Colfax and 46 per cent less than Dalmarnock. Yet the guarantees are substantially the same as those of the two American plants, though 0.1 in. lower than those of the Scotch plant. It might have been expected that the apparent deficiency in condensing surface had been compensated by an increase in the consumption of cooling water. But the ratio of circulating to condensate pump capacities does not indicate this, being even slightly less than in Colfax. There might be some reason for the two American plants mentioned having more cooling surface, on account of the higher temperatures reached by the cooling water in the summer, but this would not apply to the Scotch plant. A probable explanation lies in the diameter of the condenser tubes. The heat interchange between steam and water per square foot of tube surface is greater for smaller tubes on account of the greater ratio of circumference to cross-section. Most American condensers on large units have 1-inch tubes, whereas the Gennevilliers condensers have tubes of 0.866 in. outside diameter. This fact and the differences in summer cooling-water temperatures probably account, at least in part, for the difference in size of the American and French condensers.

An article in an early issue will deal with the heat balance and electrical equipment of the Gennevilliers station.

Convenient Foot-Operated Radiator Valve

A radiator valve that may be adjusted to any desired position by a touch of the foot, instead of by turning a handwheel, is shown in the illustration. The spindle does not turn, but slides, and is normally held in the upper position, with the valve open, by the spring *A*. By pressing with the foot on the cap that is attached to the upper end of the spindle this spring may be compressed, the spindle forced down and the valve closed. To keep the spring from returning the spindle at once to the upper position when the foot is removed, a hardened tool-steel piece *B* is provided. This piece is continually pushed upward by the spring beneath it, but is kept from rising, and also from turning, at its right-hand end by a projection of the piece just above it. It therefore tends to swing up out of the horizontal, and so the sharp corners of the hole in the middle of it catch on the spindle and prevent the latter from being raised by the spring *A*.



THE VALVE IS OPENED AND CLOSED BY FOOT PRESSURE

It is closed against the pressure of the spring *A*, and is held closed by *B*, which swings up and catches the valve stem. When *B* is pressed down by the small button, the valve opens.

When the valve is closed, with the spindle held down by the crooked position of the tongue *B*, the spindle may be released and the valve opened by a light foot pressure on the small button *C*, which presses *B* down into a horizontal plane, thus allowing the spindle to slide freely.

The purpose of the third spring *D* is to prevent the leakage that would otherwise be caused by a slight withdrawal of the valve stem after it is pushed down to the closed position and before the tongue has gripped it. In other words, the spindle is pressed down far enough to compress the spring *D* slightly, thus holding the valve tightly shut until it is released.

The spindle may be stopped and held in any position in its downward travel, but when it is released, of course, it comes all the way up at once.

The inventor and patentee is P. A. Riccio, 4547 Park Ave., New York City.

An experimental transmission line, to operate at 600,000 volts, the highest voltage ever attempted, has been recently constructed at Purdue University, Lafayette, Ind. The purpose of the line is the investigation or corona loss at high voltages, very little being known about corona discharge above 220 kv. The line is about one-third of a mile long, and is supported on 65-ft. steel towers. Two cables of any desired size may be used and provision has been made for varying the horizontal spacing between cables, by suspending them from 40-ft. channel-iron cross arms.

Diesel Engine for Small Plants

DISCUSSION of motives prompting the Nordberg Manufacturing Company to design a Diesel engine of small powers and a description of the important details of the design

THE advantage of a Diesel engine for power-plant drives increases as the size of the plant decreases. The gain in comparative economy is due to the fact that as steam equipment becomes smaller, the fuel consumption per horsepower increases, while a Diesel engine, whether large or small, has approximately the same fuel consumption. This is an advantage that is being appreciated more and more, and it makes the Diesel engine, especially in smaller units, very attractive. Since size has little influence on fuel costs, there is no advantage in using one or two large units as is necessary in steam-power plants to obtain the maximum possible efficiency. The tendency is, then, to install several Diesels in a plant in preference to a single unit, making it possible to operate each engine at more nearly its economical load. In addition the cost of the spare units is kept down, as well as the maintenance charge.

The increasing popularity of the Diesel engine has created a demand for a simple and reliable small engine. It must be simple because the class of labor employed in a small plant is not of the best. Reliability is essential, for in many plants the engine must operate for long periods. The working parts must be accessible, for when an engine is shut down and overhauled, little time is allowed for repairs and such parts as require replacement must be easily and cheaply replaced.

In general, the demand is for as inexpensive a unit as can be obtained without sacrificing any of the fuel efficiency. The engine, however, must at the same time be well built and cheapness in no case must outweigh reliability. In the larger sizes this demand immediately points to a two-stroke-cycle Diesel where the weight per horsepower is low. For small units, however, it is considered questionable whether the two-stroke-cycle engine can be made more cheaply than a four-stroke-cycle. For the same cost of building there is no doubt that the two-stroke-cycle engine can be provided with better material and better designed parts than can the four-stroke-cycle type. There is every reason to expect the two-stroke-cycle principle to be adopted more generally in the smaller plants, always bearing in mind that it must be a better built engine.

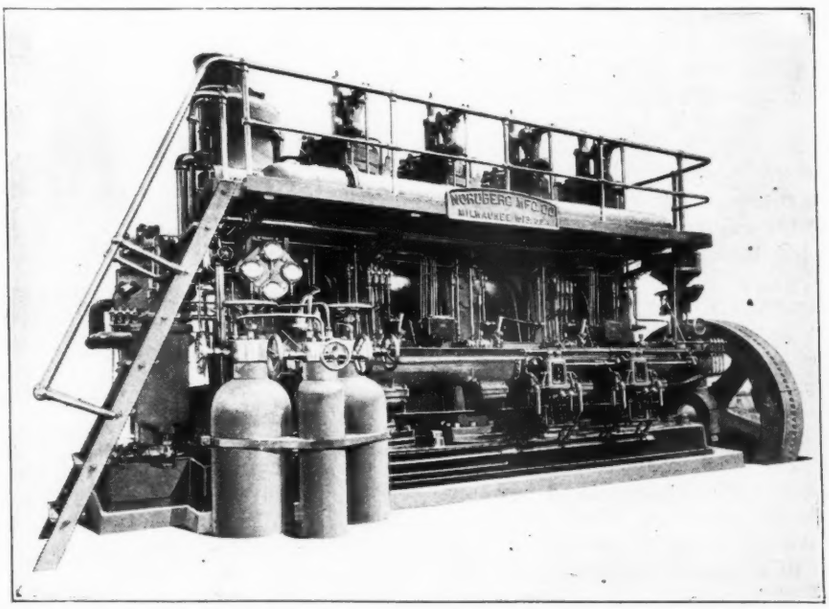


FIG. 1. TYPE V.E. FOUR-CYLINDER NORDBERG DIESEL ENGINE

As a general rule all Diesel engines are easy to operate if the engineer understands the principles of operation and has had some experience with this type of engine. It must be kept in the best of repair if it is to give good results. A careful observance of the kind of fuel oil and lubricating oil used will minimize trouble with the moving parts. It is generally assumed that a Diesel engine requires more repairs than a steam plant. Experience with a good engine proves that the difference is slight.

All this does not mean that there is no longer any use for a steam engine, but it does mean that a careful analysis must be made of all conditions to determine which type of plant meets the requirements in the best possible manner.

To meet this small-plant demand, a carefully designed Diesel engine of small horsepower has been built and developed by the Nordberg Manufacturing Co. The engine is of the slow-speed, two-stroke-cycle, port-scavenging, crosshead-type full-Diesel with open frames. The engine has a direct-driven three-stage air compressor and a double-acting scavenging-air pump to furnish the necessary starting, blast and scavenging air. The compressor and scavenging pump are driven by separate cranks from the crankshaft. Water cooling is provided for the cylinders, cylinder heads, crosshead pins and guides, pistons and exhaust pipes.

An outstanding feature is the building of the engine in three-, four-, five- and six-cylinder sizes, with a uniform rating of 110 b.hp. per cylinder. With this flexible arrangement in the number of cylinders employed, the engine can be adapted for standard generators of different sizes. A three-cylinder engine is suitable for 225-kw. generator. Adding a cylinder increases by 75-kw. the permissible generator rating, so that the four-, five- and six-cylinder engines will drive generators rated at 300, 375 and 450 kw. respectively, all being machines of standard sizes. The cylinder bore is 15 in.; stroke of piston, 20 in.; and the mean effective pressure is 55 lb. per sq.in. at the full-load speed of 225 r.p.m. The weight of the engine per

brake horsepower ranges from 260 to 280 lb., varying somewhat with the size of engine, and including the weight of flywheel, barring gear, outboard bearing, air compressor, scavenging pump, air bottles, fuel-oil tanks and filler and lubricating-oil filter and all appurtenances.

Being of the two-stroke-cycle type, the engine will burn low-grade fuel, with no restrictions as to the

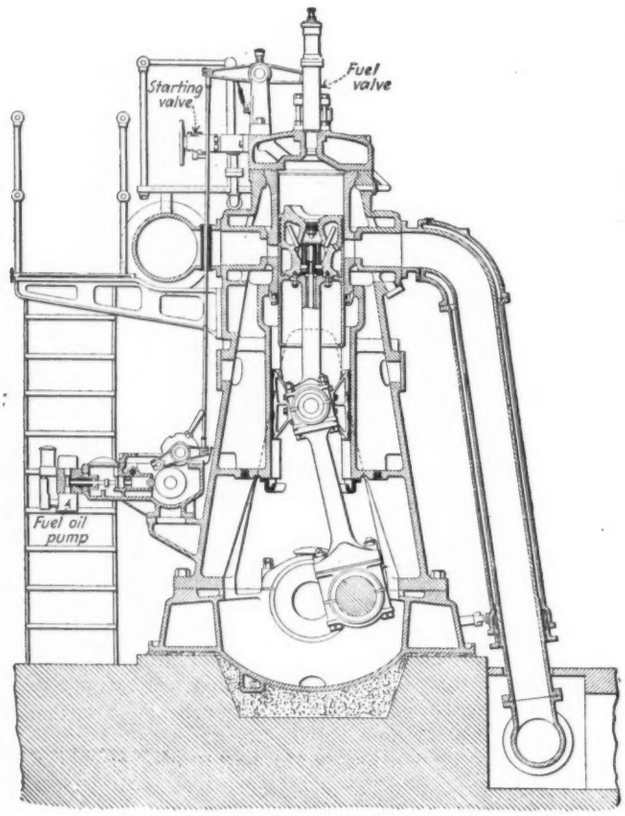


FIG. 2. SECTION THROUGH ENGINE

sulphur and asphaltum contents. Engines of the type under discussion are using oil under 20 deg. Bé. and in some particular cases Mexican fuel oil of 14 deg. Bé. The guaranteed consumption per brake horsepower-hour at full load is 0.45 lb., using an oil of 8,500 B.t.u. per lb. Actual consumption tests give lower figures.

The bedplate, which is made in one piece, is of the closed-pit type and gathers the lubricating oil from the whole engine. From the bedplate the lubricating oil flows by gravity into a filter, from which it is taken by a pump driven by the engine itself and is pumped into an overhead supply tank from which the engine is fed.

The cylinder and frame are cast in one piece, and a liner is fitted in to form the cylinder proper. The cylinder head is made of special cast iron and is designed to give a symmetrical casting of as near uniform thickness as possible. The only opening in the head is the one for the fuel atomizing and starting valves; it is designed and built so that there is access to the water-jacketed space for cleaning. The piston head is water-cooled and contains the piston rings, while the trunk, which is attached to the lower end of the piston head, is comparatively loose to eliminate any danger of seizing, this construction being possible only with an engine of the crosshead type.

Water from a header common to all cylinders is supplied to each piston head through the medium of a swinging joint, shown in Fig. 5, which is of the same type as employed on the larger engines made by the company. Water from a supply header first passes through the swinging joint into the hollow crosshead pin and piston rod and finds its way into the piston head, returning through a pipe inside the hollow piston rod and out through the crosshead pin and swinging joint on the side opposite to that at which it entered.

Fuel oil is supplied to the suction chamber of the engine fuel pump through an oil filter equipped with heating units and through a heated header. Each working cylinder has its individual pump of horizontal plunger type driven by a cam on the camshaft. The pump thus has a definite stroke and draws the same quantity of oil from the suction chamber at each stroke. On the discharge stroke of the pump a bypass valve, under the control of the governor, is opened earlier or later according to the power output of the engine. This determines the amount of oil necessary for one power stroke, and the rest of the oil taken into the pump

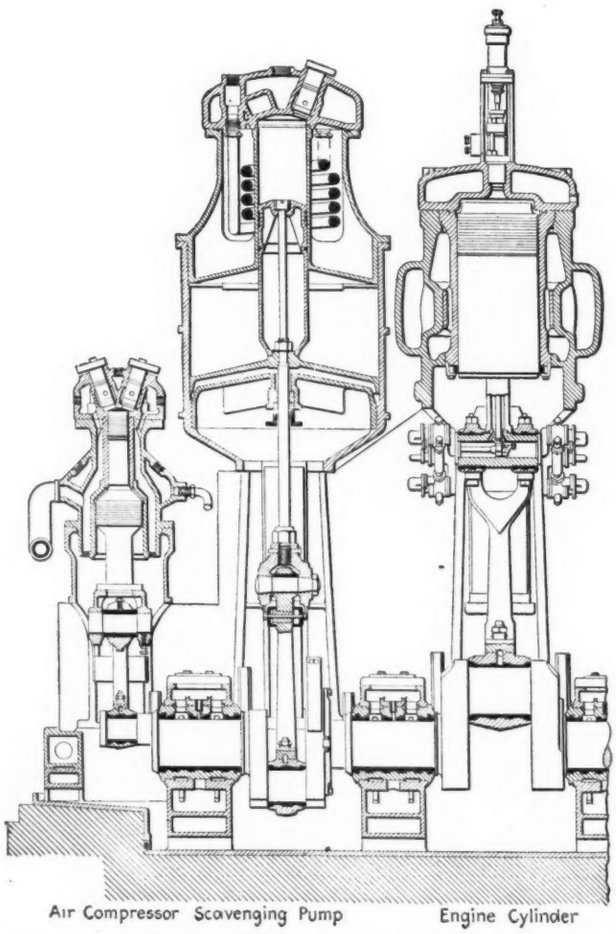


FIG. 3. CROSS-SECTION THROUGH SCAVENGING PUMP AND LOW-PRESSURE CYLINDER OF AIR COMPRESSOR

by the plunger will overflow back to the suction chamber. The governor is of the centrifugal type and is driven from the camshaft by means of an elastic coupling consisting of plate springs between driving and driven parts.

With some minor changes in the driving mechanism, the fuel valve, which is shown in Fig. 6, is the same as employed in the larger Nordberg engines. This valve

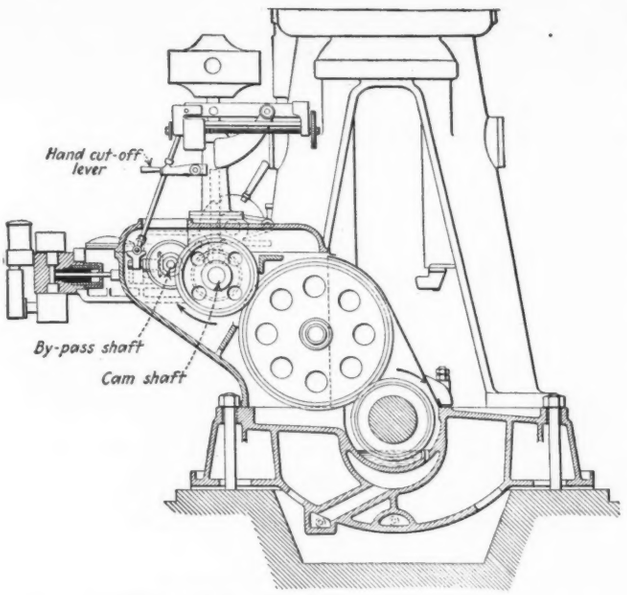


FIG. 4. DETAIL OF GOVERNOR AND FUEL PUMP

is located in the center of the cylinder head and is operated from the camshaft by means of two levers, a pull rod and a cam. As shown in the illustration, it consists of a central stem, or so-called needle valve, which is held to its seat by a spiral spring in a separate chamber above the body of the valve. This needle valve is surrounded by a concentric sleeve, the annular space between the needle valve and sleeve giving passage to the blast air. On the external circumference of the sleeve are longitudinal grooves through which fuel oil passes on its way to the cylinder. Near the discharge end of the fuel valve the oil encounters atomizing plates through which it is forced by the blast air. The finely divided oil enters the cylinder through a special shaped flame plate, and the high temperature due to the compression ignites the oil. An inspection of the drawing will show that the spring holding the valve to its seat is adjustable from the top and that the fuel valve can be easily removed for inspection without dismantling any of the surrounding parts.

The gases from each cylinder flow through the ports in the cylinder liner to a water-cooled exhaust pipe and thence into the manifold serving to carry the exhaust gases out of the engine room. As port scavenging is employed there are no admission valves for the scavenging air. The piston in each cylinder controls the opening and closing of the scavenging ports. The scavenging pump is of the double- acting, direct-driven crosshead type and is fitted with Nordberg automatic strip valves on the suction and discharge sides. The discharged air from the pump goes to the scavenging header, from which it passes to the individual cylinders through the ports in the cylinder liner at the bottom of the stroke.

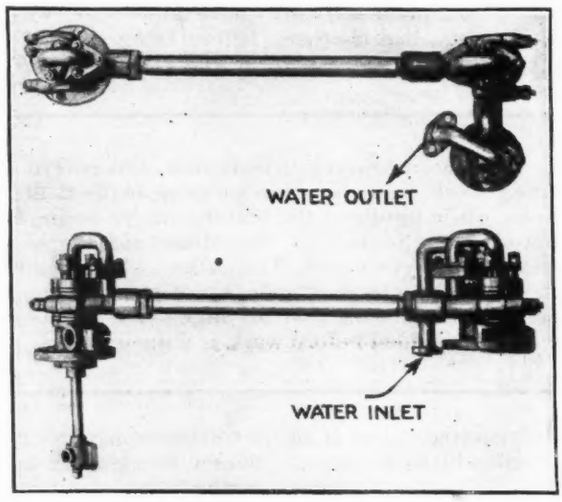


FIG. 5. SWING JOINT FOR PISTON COOLING WATER

The air-starting valve, which is of the balanced poppet type, is shown in Fig. 6. It is operated from the camshaft in the same manner as the fuel valve. A spring holds the valve closed and a handwheel is provided to tighten it when the engine is operating on fuel.

Starting and blast air is furnished by a three-stage compressor, equipped with three air coolers. One of the coolers takes care of the air coming from the low-pressure stage, another of the air coming from the intermediate pressure cylinder and the third is the aftercooler.

As shown in Fig. 3, the low-pressure cylinder is mounted above the scavenging pump and is driven from the same crank as the latter. The intermediate and high-pressure pistons are driven directly from the crankshaft through a crosshead. The valves in the compressor are of the round plate type, held in their seats by light springs. The compressor is built to compress air to 1,000 lb. end pressure to charge the starting-air bottles. The air pressure can be regulated and adjusted to the needs of injecting the fuel oil into the cylinders. The intake air passes through a suction silencer, consisting of sheet-iron plates mounted one on top of the other at the corners, similar to loghouse construction, so that the small passages provided subdivide the air currents and therefore practically eliminate the suction noise.

For a 550-hp. engine the consumption of lubricating oil averages less than 2 gal. per 24 hours. A great variety of fuel oil can be used with this engine. The fuel valve with which the engine is equipped is designed to take care of fuels down to 14 deg. Baumé.

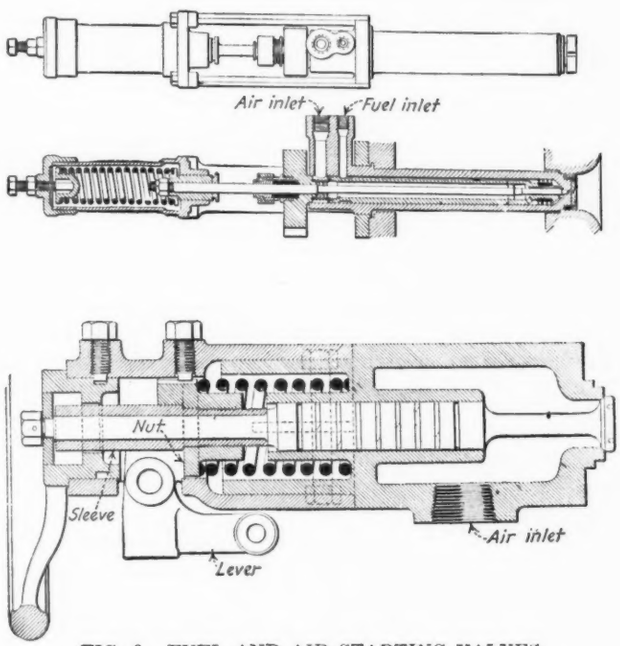


FIG. 6. FUEL AND AIR STARTING VALVES

Grounding of Electrical Conductors for Protective Purposes

By Ralph Brown

WHEN work is to be done on outside circuits, as at an outdoor substation, or on overhead transmission lines, the practice of grounding should be rigidly followed, because there is real danger of a dangerous potential being induced in an exposed ungrounded conductor, either from an adjoining live conductor, or from the atmosphere. But for electrical conductors within a building conditions are somewhat different, and as the practice of grounding has never been followed in some stations in which accidents, due to workmen coming in contact with live conductors, have not occurred, the question arises. Should electrical conductors be grounded in every station before work is done on or near them?

The most important reason for grounding electrical conductors is to assure workmen of safety, and if other measures may be taken to assure safety in the same degree, the expense and danger of using protective grounds is hardly justified. Unless provision is made during construction for grounding, it is often difficult later to install ground buses, receptacles, etc., and it may be impossible to arrange connections so that long portable ground cables will not be required. And if in a station where considerable current will be developed during a short-circuit, the ground cables and clamps must be of rather heavy and substantial construction. Consequently the maintenance and repair charges are relatively high; considerable work, and appreciable time, are required to move about and apply the grounding cables.

IN view of the fact that electrical conductors are grounded when work is to be done on or near them, in some stations, while in others the practice of grounding is not followed, the advantages and disadvantages of each method may be compared. The author, who is connected with one of the large Pacific Coast power companies, draws the conclusion that all high-voltage conductors should be grounded before work is done on them.

Unless well trained, and extremely careful, an operator may attempt to ground a live conductor, with probable serious consequences. Cases of fatal injuries and damage to apparatus have been known to occur because of an attempt to ground a live conductor; and because of the human element, trouble of this nature may develop at the most unexpected moment, even where only experienced operators are concerned, and where safety rules and safety devices are provided. And the possibility of trouble is not removed even after conductors are safely grounded, for interruptions to service and damage to equipment have resulted from the failure of the operator to remove the grounding cables before energizing the conductors, to put the circuit back into service again.

If a workman knows that the conductors on which he is about to work have been grounded, he naturally feels positive that they are dead, and therefore perfectly safe. But it may be reasoned that the same assurance of safety can be given by the operator's carefully testing the supposedly dead conductor for potential with a suitable testing device, and, if no potential is indicated, touching the conductor before giving the workmen a clearance card. If all of the disconnecting switches and oil switches which might energize the conductors by being closed are properly blocked, and protected by clearance signs, the isolated conductors cannot be accidentally energized.

The objection to assuming that a conductor is dead because so indicated by a testing device lies in the fact that since all testing devices are not infallible, the conductor may actually be energized, even though the potential testing device indicates that it is dead. Depending on the person and contact made, a voltage of less than 250 volts to ground may cause death, and this is an important reason why a conductor should be grounded before being touched. Even where there is no question of the conductors or certain apparatus being isolated from all sources of power, there is a real danger of a static discharge from a conductor causing a severe shock, and a discharge may be obtained from electrolytic lightning arresters that have been disconnected from the circuit for hours. One satisfactory method of testing a conductor for potential is by means of a suitable condenser mounted on an ordinary switch stick, and this method is reliable for 2,000- to 13,000-volt circuits. For voltages of 6,600 and above, the static discharge to the metal end of a switch stick is an indication of potential.

Assuming that a bus is not grounded, the possibility exists of a flashover or short-circuit developing near an ungrounded isolated bus, and establishing a dangerous potential therein. However, the possibility of a workman being injured by such an occurrence is extremely remote; in fact, there is more danger of an operator being injured by attempting to ground a live conductor.

It is a fact that every reasonable precaution should be taken to insure the safety of workmen; and because, where electrical conductors are involved, grounding and short-circuiting makes an otherwise possibly dangerous circuit absolutely safe, it appears that the practice of grounding should be consistently followed when work is to be done on dead conductors of a circuit, the normal potential of which is 250 volts or above.

If due care is exercised, the mistake of grounding a live conductor will not occur, nor will grounded cables be left connected to a circuit that is energized. An important precaution to be taken when applying any grounding device is to make good contact with the conductor at once, so that an arc or flash will not develop if the conductor should, by some mischance, be energized, and grounding clamps should always be applied at the end of a switch stick, if possible.

As the possibilty of the occurrence of mistakes in the application and removal of grounds offers the principal objection to the practice of grounding, the logical plan seems to be to follow the practice, and always exercise extreme care to avoid mistakes. Operators are usually held responsible for the application of grounding cables, and the importance of exercising care in this operation may be impressed on them, but they, being human, occasionally make mistakes, in spite of the best intentions and the most explicit instructions. However, it is thought advisable to insure the utmost safety to workmen, even though damage to apparatus or an interruption to service may result from possible error in applying or removing the very devices that afford the best protection known.

Loss of Power in a Gas Engine

By Earl Pagett

There are many causes for gas engines failing to pull their rated load, but they may be brought under about four general classes, namely, leakage, faulty or improper valve and ignition timing, and overheating of the cylinder and piston with consequent faulty lubrication.

Under the first heading will come piston-ring leakage, valve leakage, and on the double-acting engine, packing-cage leakage. Usually, leakage of either kind comes on gradually and there will be a falling-off of power developed from day to day. The engine will be harder to start each time and will finally refuse to start at all in the event that all cylinders are affected.

If an indicator is available (and it should be in all up-to-date plants), indicator diagrams will serve to locate the cylinder at fault. Where an indicator is not at hand, cutting each cylinder out separately and noting which one affects the speed the least, will serve as a good rule-of-thumb method.

Finding Cause of the Leakage

The faulty cylinder located, the next step is to distinguish the source of leakage. Stuffing-box leakage, being audible, is obvious, but piston-ring and valve leakage is harder to detect. Exhaust-valve leakage may sometimes be detected by taking a pencil or long stick firmly between the teeth, placing the other end on the exhaust pipe, covering the ears and watching the igniters. If a faint hiss is heard at the moment of ignition and prior to the exhaust-valve opening, it is a good bet that the exhaust valve is leaking and will have to be reseated. The exhaust pipe from the leaking valve will also be abnormally hot.

Piston-ring leakage on a single-acting gas engine may be detected by the blowing by of the gases into the crankcase. It may also sometimes be detected on the tandem double-acting engine firing in the one, two, three, four order by a heavy premature ignition in one cylinder end, caused by the burning gas from the opposite end, which is at the firing point, blowing by the piston and igniting the charge in the end under discussion.

If the engine can be shut down for a test, the best way to detect a leak is to block the flywheel with the suspected cylinder piston in firing position and turn on the starting air. If the starting air whistles out into the crankcase in the single-acting engine or out of the firing cock on the opposite side of the piston in a double-acting engine, the trouble is piston leakage, and if it whistles out into the exhaust pipe it goes without stating that the exhaust valve is leaking.

Inlet-valve leakage does not often occur, but can be detected by backfiring and by the warming up of the inlet pipe. Leakage of any description takes the "pep" out of a gas engine and should not be tolerated. The longer a leak exists the worse it gets, and, as stated before, it will finally get so bad that the engine cannot be started.

Use of Wrong Mixture

A wrong mixture will decrease the power if varied too far from correct. Theoretically, for natural gas, it should be in the neighborhood of nine parts air and one part gas by volume. On engines using a qualitative governor, the mixture varies between too lean to fire at light loads and too rich to fire at heavy overloads. The governor should be set so that the maximum economic mixture will be reached at rated engine capacity, with a correspondingly lean mixture for lighter loads.

The mixture on engines using quantitative governing is usually adjusted by hand and should be kept as lean as possible for satisfactory operation. A good rule-of-thumb method is to adjust the mixture so that a good blue flame is obtained when the firing cock is opened. It may have to be enriched slightly at heavy loads. This method cannot be used in stations where too much gas in collected, and the indicator and exhaust-gas analyses will have to be resorted to.

Overheating is usually caused by the liming up of the water passages, or insufficient cooling water. This will indirectly reduce the power of the cylinder by allowing such a high cylinder temperature that the oil does not lubricate, but burns off the cylinder and piston. If the pistons are close fitting and not water-cooled, the excessive temperature may expand them enough to stick in the cylinders, or at least rub the walls so hard that the load will have to be reduced or the engine will drag and finally stop.

An engine should not be run without a proper supply of cooling water, or with the passages limed up, and there should be no interruption in the supply. There are often temptations to keep the engine running for a short period with scant cooling water, resulting from some derangement of the water supply system, but this should never be done. The engine should be shut down until the trouble is remedied. In starting, the cooling water should be turned on before the engine is started, and allowed to run for a time after the engine is closed down.

One plant was troubled with an unaccountable number of broken exhaust valves, cylinder heads and packing cages, and the writer attributes the cause to the fact that the water was shut off when the engine stopped. The remaining heat warmed these parts to such a high temperature that, upon starting after a brief shut-down they cracked when the water was turned on again.

If bad cooling water is used, the jackets should be cleared of scale periodically. It may be eaten out of the inaccessible places with muriatic acid, care being taken to wash out all traces of the acid.

A good grade of high-fire low-carbon oil should be used, but no oil will do any good in a gas-engine cylinder unless the cylinder temperature is kept within reasonable limits. The cylinder oil should also be fed regularly and without interruption, force feed lubricators being

almost a necessity in this class of work. Excessive oil will develop carbon which will in turn cause premature ignition and pounding. A small amount of water admitted with the gas will help to keep carbon down, the writer having noted that there is never any carbon present in a cylinder that is leaking cooling water into the combustion chamber.

Valve Timing

If it is determined that there is no leakage, good lubrication and proper mixture, and still the engine does not pull, the timing should be investigated.

The working of the valves, piston and igniters has a definite relation, and the power developed will decrease as this relation varies from correct. The proper timing of the large gas engines is usually marked on the flywheel, and it is a simple matter to check up the timing and see if a cam has slipped or a push rod come loose.

Twenty degrees off time on the ignition will decrease the capacity of an engine at least one-third, so it is easy to see from this the importance of keeping the timing right.

New Jones Stoker Is of the "Lateral Retort" Type

The latest product of the Underfeed Stoker Company of America is the "lateral retort" underfeed stoker, which practically consists of two regular Jones multiple-retort stokers arranged back to back so as to form a main retort between them, from the front wall to the bridge wall, with lateral retorts branching off at right angles. This arrangement is clearly shown in Fig. 1. The coal is pushed through the front wall at the right into the central retort, from which it is distributed into the lateral retorts, the underfeed principle being maintained throughout.

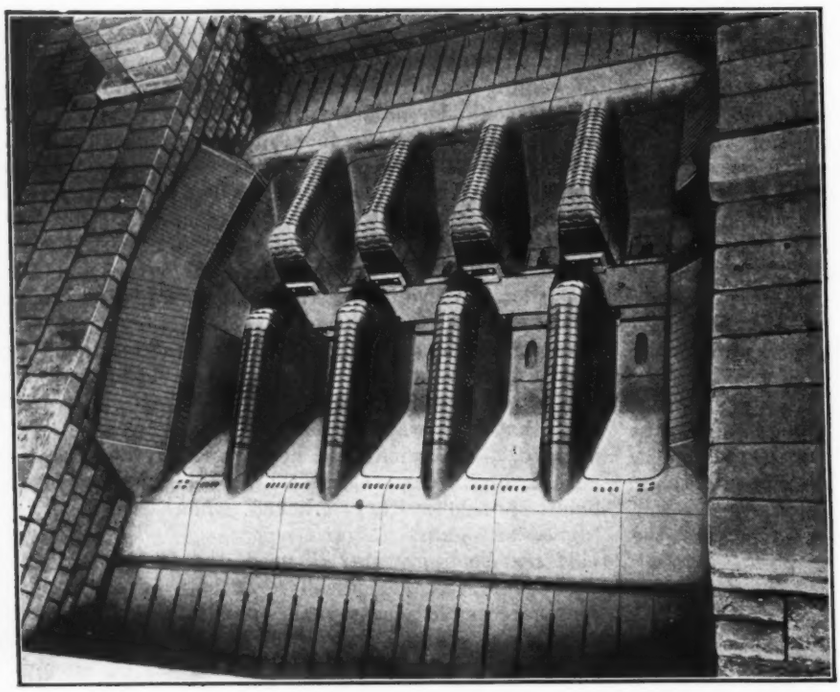


FIG. 1. THE NEW STOKER, CONSISTING ESSENTIALLY OF TWO JONES A.C. STOKERS PLACED BACK TO BACK

Coal is fed by the main ram through the front wall at the right into the central retort, being then distributed into the lateral retorts by auxiliary pushers.

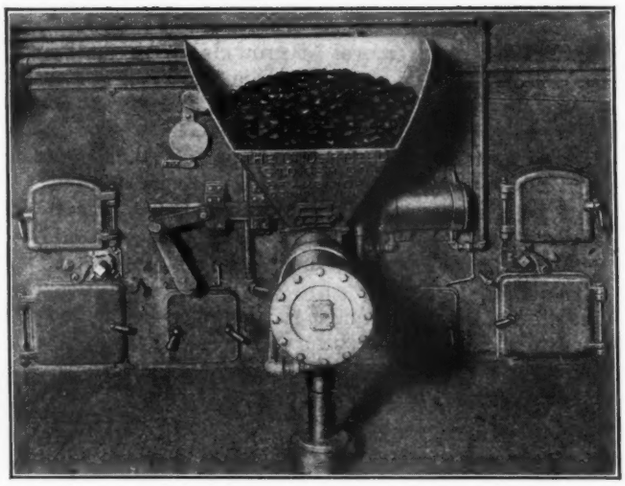


FIG. 2. THE FURNACE FRONT, SHOWING THE MAIN RAM CYLINDER, AND, AT THE RIGHT, THE AUXILIARY CYLINDER FOR OPERATING THE LATERAL PUSHERS

In Fig. 2, showing the front of the furnace, may be seen the steam cylinder that operates the ram for pushing the coal from the hopper above into the central retort. Just to the right of this cylinder may be seen a smaller one, which, through a system of levers and links, operates auxiliary pushers for forcing the coal from the central retort into each of the lateral retorts. The auxiliary cylinder is independent from the main cylinder, and so the length of timing of the stroke of the lateral pusher blocks may be controlled independently of the motion of the main ram.

As will be noticed in Fig. 1, the stoker is of the side-cleaning type; in this respect the design follows closely that of the Jones A.C. stoker; the dump plates are counterbalanced and interlocking at the tip end. An auxiliary air supply under the dump plates is provided for burning any particles of coal that may reach them.

The side-cleaning arrangement eliminates the necessity for a large ashpit under the stoker, and since the stoker is set very low it may be installed under low-set boilers already in service without great difficulty. It is stated that a trench 6 to 18 in. below the floor line is all that is necessary for the ashpits.

The right proportion between the rate at which coal is fed into the furnace and the air supply is maintained, as in the Jones A.C. stoker, by the Cole automatic valve, which is belted to the fan. As the speed of the fan, as controlled by the fan engine regulator, increases or decreases, the speed of the main ram and the auxiliary pushers is varied accordingly by the automatic valve, which controls the steam supplied to the main and auxiliary cylinders.

If the furnace is not wide enough for the full-sized stoker, the design may be changed, keeping only the central retort and the lateral retorts on one side.

What Expansion Without Loss of Heat Means

THE action of steam or gas in an engine may be compared to the events in a hydraulic system. This article points out that entropy may, for all practical purposes, be regarded as the heat weight, while the temperature may be considered the head.

IN a previous article the temperature-entropy diagram was discussed. As was pointed out, this consists of a chart whose ordinate is proportional to the absolute temperatures and whose area is proportional to the total heat in B.t.u. The abscissa is called the entropy of the substance. Such a diagram covering the action of one pound of water in being evaporated at a definite pressure, expanded in a cylinder, condensed and then heated to the initial temperature, making a complete cycle, is shown in Fig. 1. It has

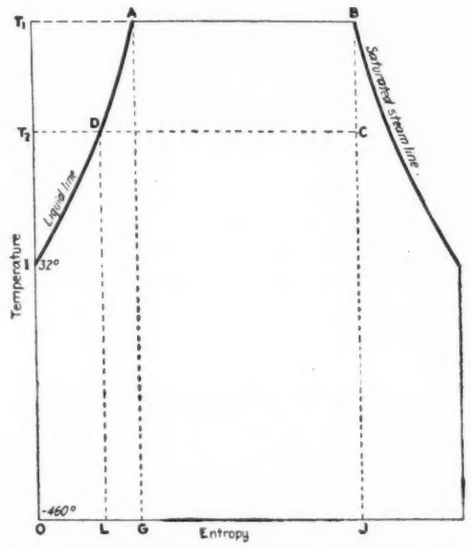


FIG. 1. TEMPERATURE-ENTROPY DIAGRAM OF A RANKINE ENGINE

been pointed out that during adiabatic expansion or compression no heat is added or subtracted as heat; and that during adiabatic expansion or compression the entropy is constant. But the engineer knows that the work done in expansion uses up some of the heat in the steam. For this reason he has no clear understanding of why the entropy is constant nor of the statement that no heat is added or taken away. This may be cleared up by making use of a hydraulic analogy that somewhat elaborates a similar idea published a number of years ago.

Suppose we had a system of elevator buckets as in Fig. 2. This system consists of a horizontal run, a vertical line and a second horizontal run at the bottom, together with a return vertical line, making a complete system. At the top is a sluice discharging water into the buckets. The weight of the full buckets at the right causes the chain of buckets to move downward, driving some power-consuming machine. This water is discharged at the bottom at the level h_2. The buckets move to the left, pass over the idler, where they are lifted up to the level h_1 again. Now the system taking water from a level h_1 and delivering it at the level h_2 does work. If the chain travels at a definite rate per minute, handling W pounds of water per minute, the work done is Wh foot-pounds when h is the difference in head between the headrace and tailrace. It is then possible to have the horizontal length of chain represent to some scale the pounds of water handled per minute. We have, then, a square the width of which is proportional to the pounds of water handled per minute and the height is proportional to the working head in feet.

The area of the figure $ABCD$, being the product of the width and height, is proportional to Wh, or the work done in foot-pounds. This work diagram may be set on a chart whose abscissa represents weight in pounds and whose ordinate represents head in feet measured from zero head or sea level. The ordinate OY would be set to the left of the Wh diagram a distance proportional to the tare weight of the chain per foot times the travel in feet. Calling this W_1 and the weight of water W, it is seen that the total weight moving downward per minute is $W_1 + W$. The positive work per minute

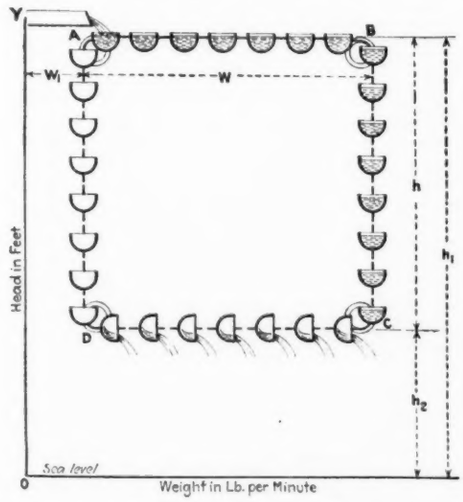


FIG. 2. WORK DIAGRAM OF A WATER POWER

is $(W_1 + W)h$ and the negative work of lifting the empty buckets is W_1h. The net work is then Wh and the efficiency is $\frac{W(h_1 - h_2)}{W(h_1)} = \frac{h_1 - h_2}{h_1}$.

Turning now to the heat problem, assume that we are dealing with a gas. As shown in the last article, we may construct a diagram whose area is the total heat change in a given weight of gas during a complete cycle. Suppose now, as in Fig. 3, we add heat to the gas at a constant temperature T_1, then allow it to expand adiabatically doing work, then reject the heat that is left in it at a constant temperature t_2 followed

by adiabatic compression of the gas to the initial pressure. This gives a complete cycle of events and represents what is called the Carnot cycle of adding heat and ejecting heat at constant temperatures. The work done during the cycle may be represented by a rectangle *ABCD* in Fig. 3.

Suppose we forget for the moment that we are dealing with a gas and assume that it is heat that is being taken in at one level and discharged at another. We can imagine that we have a chain of buckets just as with water. These buckets are taking in entropy or heat weight at the height T_1 and discharging it at T_2. Since there is some entropy left in the gas at *D*, the heat diagram may be placed away from the zero entropy line as shown. Now the amount of entropy put in the buckets at the height T_1 is proportional to the horizontal distance or to the width of the diagram and is equal to the entropy at *B* less the entropy at *A*. This heat weight in falling from T_1 to T_2 along the line *BC* does work measured in heat units (this is adiabatic expansion). This entropy is discharged at the lower temperature T_2 (this is the act of cooling at a constant temperature or isothermal compression). The buckets return along *DA*, and from *A* to *B* a new amount of entropy or heat weight is discharged into the buckets per minute. The area represents, as stated before, the heat converted into work and is proportional to $(N_B - N_A)(T_1 - T_2)$ or NT. Now when the entropy

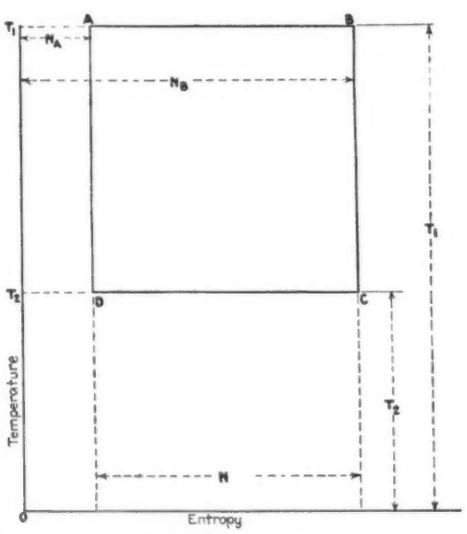


FIG. 3. *T—N* DIAGRAM OF THE CARNOT CYCLE

was discharged at the level T_2, there was in it potential energy measured above the zero temperature level equal to NT_2, just as in case of water we had a residual energy of Wh_2 in foot-pounds. The efficiency of the hydraulic system was the work done compared to the

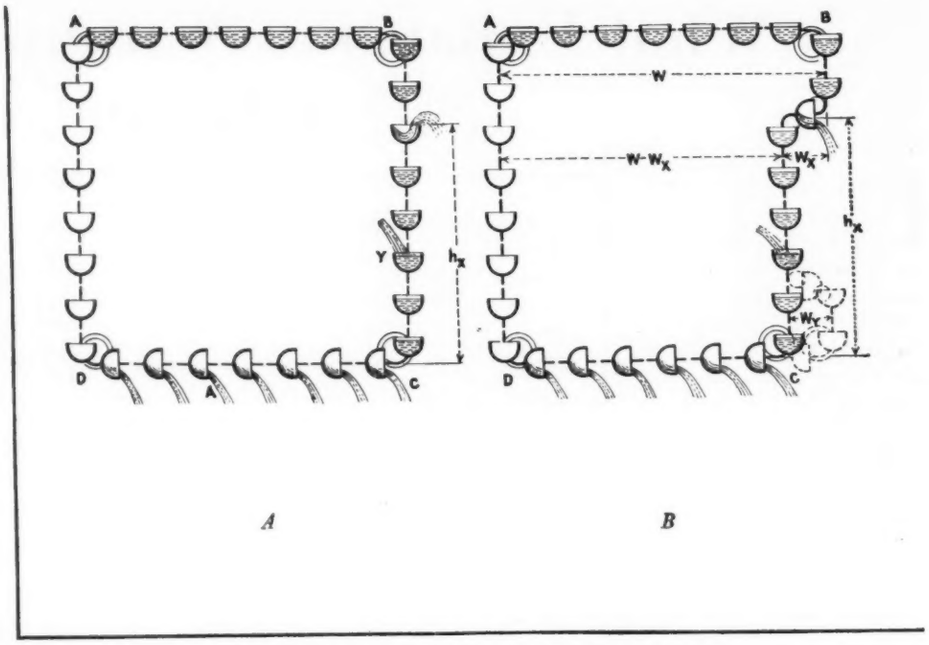


FIG. 4. EFFECT OF LEAKS ON WORK DIAGRAM

energy in the water measured from zero head, and reduces to the expression $E = \frac{h_1 - h_2}{h_1}$. In the case of a gas when the entropy is put in at the temperature T_1 and discharged at T_2 with no loss in the progress from T_1 to T_2, the efficiency, which is the energy converted into work divided by the total energy above the zero temperature level, becomes $\frac{N(T_1 - T_2)}{NT_1}$ or $E = \frac{T_1 - T_2}{T_1}$.

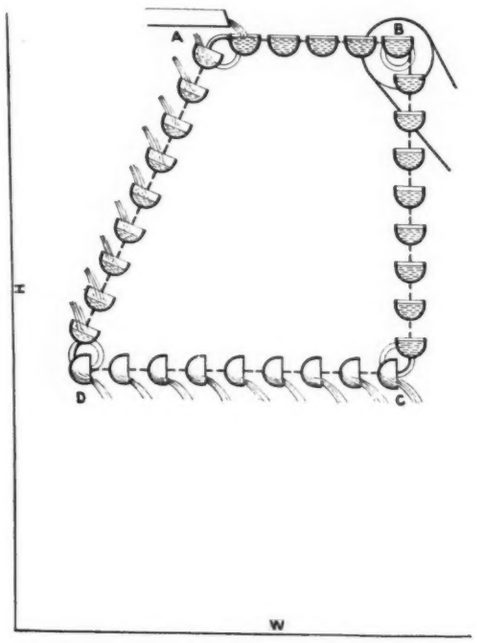


FIG. 5. ADDING WATER ON RETURN LINE

Reverting to the hydraulic system, suppose as in Fig. 4A some of the water spills out as the chain descends. Now this reduces the work developed by an amount depending upon the weight of water loss and the height h_x when it spilled out. From the work diagram must

be deducted an area proportional to the lost energy, which we will call $W_x h_x$. This could also be done by drawing in the diagram at the level h_x, giving the net-work diagram in Fig. 4B. On the other hand, suppose that some water W_y dropped into the buckets from some other supply at the point y. The extra work secured from this additional water is $W_y h_y$. The work area is changed by this as indicated by the dotted outline. It is not hard to imagine that a spilling and addition at a number of places causes the width to vary at a number of places.

Assume on the up return travel from D to A, some water spilled into the buckets. It is clear that under these conditions part of the water is added at a level below h_1 and possesses only the net energy as represented by its weight W_z times the height at which it was added h_z. The diagram must then be reduced in width. It is conceivable that some water is added all along DA. This would then require the reduction of the work area as shown in Fig. 5.

Turning now to our heat diagram, we know that heat is lost to the walls of the actual engine cylinder during expansion. In effect this amounts to a loss of entropy at a temperature level T_x. Imagine our buckets in descending from T_1 to T_2 to spill out some entropy N_x. At the level T_x our heat loss is $N_x T_x$, and as with the hydraulic diagram, we must reduce the width of our chart from N to $N - N_x$ to account for the loss Likewise, if heat is added from the cylinder walls, in effect entropy N_y is added, so our width is increased at T_y. The net entropy is spilled out at the level T_x, and on the return trip of the buckets from D to A if entropy is added (that is, heat absorbed from the walls), the diagram would be reduced just as with the hydraulic diagram, and if entropy is spilled out (heat lost) the diagram would be enlarged in width.

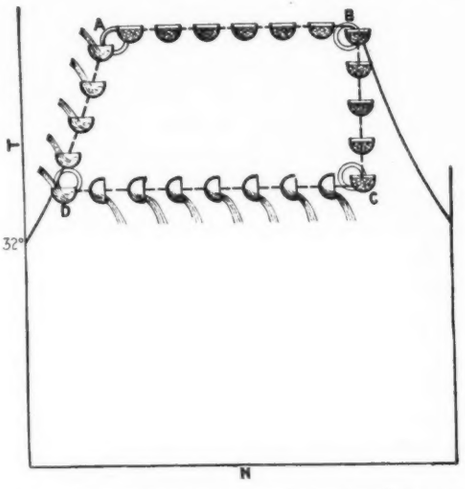


FIG. 6. ADDING HEAT WEIGHT IN STEAM CYCLE

If no entropy is lost or gained during the up and down travel of the buckets, the process is adiabatic. Just as when water is spilled after doing work from h_1 to h_2, causing a loss of work measured by the decrease in the work area, so if the expansion of the gas is not adiabatic but heat is lost (entropy spilled out), there is a loss of energy converted into work. If, on the other hand, this entropy spilled out from some of the buckets at T_x is returned at T_y, there still exists a loss of energy represented by the entropy times the temperature difference $N_x(T_x - T_y)$.

The reader will see that the greatest efficiency occurs when no entropy is lost; that is, when the expansion is adiabatic. In case of entropy lost and afterward returned, there is a loss of work as in the case of water. Likewise it is evident that the higher the level at which the entropy is added and the lower the level at which it is removed, the larger is the diagram area and the greater is the efficiency of the cycle.

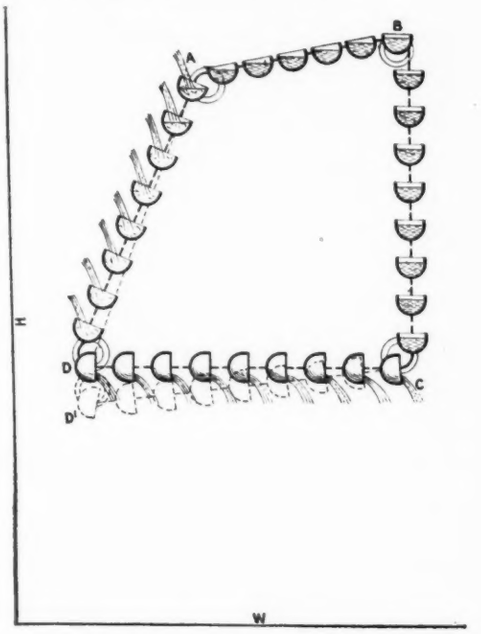


FIG. 7. ADDING AND REJECTING WATER AT VARIABLE HEADS

Now considering steam. There is a change in state from water to steam in the boiler, and as shown in the discussion of the heat diagram the $T - N$ diagram for steam has a sloping liquid line. Let us see how the hydraulic analogy applies. We have seen that if water is being continually poured into the buckets on the up trip, the chart must be drawn in to compensate for this, as has been done in Fig. 5. Likewise in the case of steam, the water in the boiler is warmed from the feed-water temperature to the steam temperature. This means that entropy is added to our buckets all the way from T_2 to T_1. The diagram is reduced in area as shown in Fig. 6, the left-hand line being the "liquid line" of the $T - N$ diagram.

Suppose that in our hydraulic system the water was not added at a constant level h_1, but at an increasing level. Likewise it could be discharged, not as h_2, but at a reducing level. The work diagram would then become as shown in Fig. 7.

Now with steam, unlike a gas, we can have only a certain amount of heat in pounds of steam at a given pressure, for if more is added the steam changes its state into that of a gas and becomes superheated. If we are going to take in the entropy at 358 deg. F. (corresponding to 150 lb. abs.), the total amount of entropy necessary to add to make the steam dry is 1.5692 units of entropy. Of this 0.514 unit is added to the water from T_2 to T_1 and 1.055 added at T_1. If the temperature T_1 is 316 deg. F. (776 deg. absolute), then the total entropy is 1.615, of which 0.459 unit was added as the water was lifted for T_2 to T_1.

If the steam contains more heat—that is, if more entropy is added after the line AB reaches B on the

saturation line—provided the pressure is kept constant, the temperature rises along BB^1 at a rising temperature but a constant pressure. The work area of the Rankine engine is then $ABB'C'DA$ as in Fig. 8.

If the engineer in studying the question of the heat cycle of an engine will consider that this analogy of

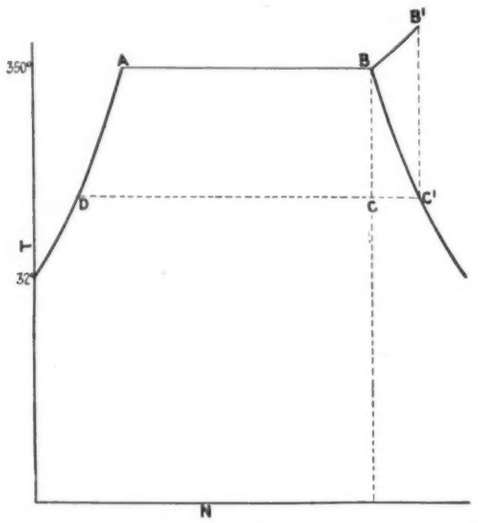


FIG. 8. *T—N* DIAGRAM FOR SUPERHEATED STEAM

hydraulics represents fairly closely the heat events and that entropy is the heat weight and is added to or taken away from the working substance when the latter is heated or cooled, then his aversion to the term entropy will disappear and the meaning of adiabatic expansion and compression will be easier understood.

Removing the Cause of High Mica in Commutators

THOS. H. WATSON

When one or more adjacent commutator bars become black and badly burned from sparking, the cause, in numerous cases, has been laid to high mica. High mica is, in reality, not high but is in its original position after the segments have been burned down by excessive sparking. The mica in places on the commutator where the brushes do not rub is still flush with the surface of the commutator.

This trouble is primarily due to dry brushes with too much tension. The brushes by their abrasive action pick up small particles of copper, which become embedded in the wearing surface of the brush. The first evidence of this is a periodical chirp of the brush, which in time becomes a sharp click accompanied by a spark each time the affected bar passes the brush. Each time the affected bar passes the brushes they are tripped, with the result that the original black speck becomes larger and so causes other brushes to spark. Soon, if this condition is allowed to exist, the bar becomes burned down below the surface of the mica. When the brush is tripped off the commutator it takes some time for it to regain its proper position and this results in the spreading of the black spot. The longer the machine is run the greater will be the number of bars so affected.

There are only two ways in which mica might raise itself above the surface of the commutator. The mica might be cut too short, which is unlikely, as it is cut to gage a trifle longer than the bar. The second, a short-circuit between the bars might so raise the temperature of the bars that the compound used in building up the mica might become softened and allow some of the mica to be forced up.

In resorting to undercutting to prevent the so-called high mica, other troubles are started which are in themselves as harmful as the ones first mentioned. Unless the undercutting is carefully done, small particles of copper may be bridged across the mica, causing a short-circuit. The operator, disliking the job of undercutting, may decide to cut the mica deep so that he will not, for some time at least, be called upon to do it again. In this case, oil and dust find lodgment in the slots and, bridging the mica, cause what appears to be strings of fire to follow around the commutator. These may burn themselves off or may short-circuit the bars and damage the winding.

Trouble due to so-called high mica can be eliminated by properly lubricating the brushes, provided they were of the proper type when new. If there is an old set of brushes around the plant they should be wiped clean and their wearing surface sandpapered to remove the glaze. Get some paraffine and bee's wax, about one pound paraffine to one quarter pound bee's wax, put in a pot along with the brushes to be treated and put in a hot place to melt, such as on the brick work at the rear of the boiler, where the mixture will be kept hot without burning, and leave for a day or two. The porosity of the brushes can be seen by the small bubbles that rise to the top of the wax. Take the brushes out and stand them on end, wearing surface down, and leave them for a day in the same temperature to drain, wipe them clean and they are ready for use. In setting the brushes, care must be taken to sandpaper them to fit the surface of the commutator. The black spot on the commutator should be cleaned with fine sandpaper, and if the mica sticks up at all it should be shaved level with the commutator. Do not put too much tension on the brushes at first, but increase it should there be sparking. The proper tension is best found by experiment.

In numerous cases I have stopped the trouble caused by high mica by the simple remedy given here; the life of the commutator has been lengthened by removing the cause of frequent grinding with a stone or truing up the commutator with a tool, and the work of undercutting has been entirely eliminated. Any carbon-brush company will gladly give information regarding the right kind of brush for different conditions of service, but remember that the brush will not give satisfaction when its original lubricant is exhausted. The cost of an extra set of brushes is relatively trifling when the price of a new commutator is considered.

Grounding of the neutral of three-phase generators in order to limit the voltage stresses to ground throughout the system has practically become standard practice for both 25- and 60-cycle systems. This can best be accomplished by grounding solidly, and such practice is usual, except in large generating systems, in which most of the energy is transmitted at generator voltage through underground cables. On most of the large systems it has been found desirable to make the ground connection through a current-limiting resistor, in order to limit the ground currents.

Lubricating Requirements of Steam Cylinders

By W. F. OSBORNE
Supervisor Manufacturers' Service Texas Company

A STEAM cylinder is lubricated to reduce wear of the cylinder wall, the piston and its rings, and to reduce the power losses caused by friction. In connection with the cylinder lubrication it is necessary to lubricate also, the piston rod, the valves and the valve rods or stems.

Cylinder friction is a very large proportion of the total friction losses of an engine and sometimes eats up as much as 10 per cent of the coal pile. Some engines will run freely for many revolutions after the steam is cut off; others slow down as if a brake had been applied. The free-running engine can be made to slow down quickly if the cylinder oil has been cut off for a time before shutting it down, showing very clearly that the braking effect is due to cylinder friction.

When the Cylinder Is Getting Oil

It is easy to tell when a cylinder is not being properly lubricated, by the action of the engine when running or by the length of time it will run after the steam is shut off. Every engineer knows, when he hears a groaning sound coming from the cylinder, that the piston or rings are not sliding freely over the cylinder wall. If he sees the valve rod vibrating excessively or a Corliss valve fail to come back after being tripped, he knows that at some point the valves are not getting proper lubrication. An experienced man with a sonoscope can tell when a cylinder is receiving insufficient lubricant and can also frequently tell exactly where the dry spot is.

We cannot expect to secure within the cylinder the same sort of film lubrication we are able to maintain in cylindrical bearings. There seems to be no way at all by which a film can be maintained on the cylinder wall thick enough to hold the piston and rings from any contact whatever with the wall. A flood of oil cannot be supplied to the wall as is done with a circulatory system for bearings, because the quantity would be enormous and most of it would be carried out of the cylinder at every stroke anyway. Furthermore, if a thick film of oil should be formed, the oil would drain off by gravity, owing to its low viscosity at the high temperatures encountered in steam cylinders. In fact, most engineers would ridicule such a proposition. Another thing, piston rings could not be made to slide on a wedge-shaped film of oil, because if they did, they would leak steam also.

Condition of Cylinder Walls

The best we can hope to have is sufficient oil on the cylinder wall to saturate thoroughly the pores of the metal and to form and maintain a smooth surface on wall, piston and rings. A properly lubricated cylinder will have a bright surface as smooth as glass, free from any rough or porous spots. Piston and rings should be in like condition. Then friction will be reduced to a minimum and the engine will run smoothly and quietly, free from noises and vibration caused by lack of sufficient and proper lubrication. Furthermore, this condition must be maintained under all kinds of adverse influences of temperature, pressures, moisture, alkaline water, sediment, piston speeds and steam velocities.

Although there are many different mechanical designs of pistons, cylinders, valves, etc., some of which require special attention in many respects, there are only two general methods of applying the lubricant. One plan consists of feeding the oil direct to the rubbing surfaces. Poppet-valve stems and Corliss valves are lubricated in this manner, the oil being delivered directly to the rubbing surfaces. Piston rods are sometimes lubricated by introducing the oil into the packing gland or by feeding the oil directly onto the rod from a drip cup mounted on the top of the gland.

Attempts are frequently made to lubricate the piston and cylinder wall by introducing the oil directly through the cylinder wall at the top or side, the idea being to have the piston spread the oil over the cylinder wall. Lubricators have been designed and connected to the engine in such a way that the drop of oil is delivered to the cylinder just at the time the piston covers the oil hole. In this way the oil is discharged directly between the rubbing surfaces. The difficulty lies in reducing the volume of the pump discharge so that oil can be delivered at every piston stroke and still keep the quantity within reasonable limits of economy.

Poor Lubrication

When the pump delivers the drops of oil to the cylinder at irregular intervals, it seldom reaches the cylinder at just the proper moment and is more than likely to be thrown against the piston head and the cylinder heads or wall by the swirling action of the steam. Most of the oil landing on the cylinder heads is lost because it runs down to the bottom of the cylinder, collects in the counterbore and may be carried out through the exhaust. When any quantity of oil collects on the piston head, it will run down to the bottom of the cylinder and will lubricate at the point where there is the greatest pressure. If the piston rings happen to be worn and sharp, most of this oil is immediately scraped off to the ends into the counterbore, where it is lost.

Part of the oil on both cylinder heads and piston head of course is atomized by the velocity of the steam coming in contact with it and may be of some benefit in lubricating the walls and exhaust valves. A distinction must be made between the oil that is atomized and that which is evaporated from the cylinder heads by temperature, as the latter exists in the steam in vapor form and can be of little value as a lubricant unless condensed.

We see, then, that even when the so-called direct feed is used, there is little effective lubrication except that given by the oil that has been atomized by the steam and spread on the cylinder wall.

Every part of a steam cylinder that requires lubrica-

tion is touched at least once in every revolution by the steam. This applies also to the greater portion of the valve surfaces. If the steam could be made to carry oil in suspension and deposit it on all these surfaces, we would have the best possible means for lubrication. We cannot expect to have a film of lubricant so thick that the metal cannot touch, such as we have in bearings, because such a quantity of oil would never remain on the wall. We can, however, by a proper combination of oil and thorough atomization, maintain enough oil to reduce the friction and wear to a minimum.

When the oil is finely divided into minute globules and such globules are thoroughly mixed with the steam, a small quantity of the oil will come in contact with every square inch of surface touched by the steam. If it has the proper characteristics, it will adhere to the surface of the metal, even displacing any moisture that might be there first. The oil will then spread and form a film over all the metal surface and in this manner reduce the friction, power losses and wear.

A.C. Automatic Reclosing Switching Equipment

Two types of automatic reclosing circuit-breakers have recently been developed for use on alternating-current service for the protection of station apparatus from short-circuits and heavy overloads occurring on distribution lines. The two types have been developed for indoor and outdoor installation respectively and are

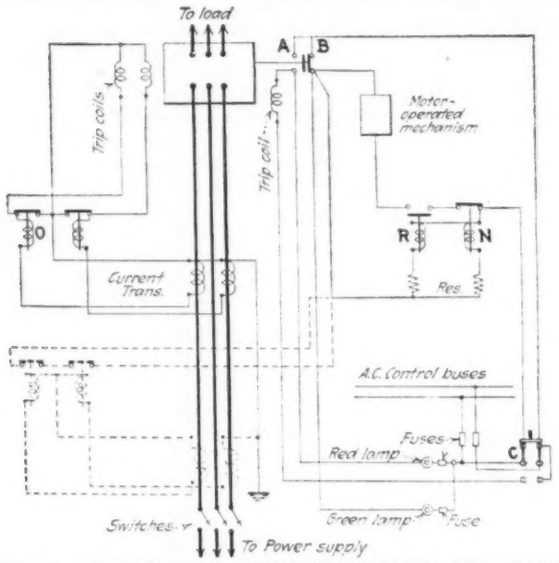


FIG. 1. DIAGRAM OF CONNECTIONS FOR AUTOMATIC RECLOSING CIRCUIT-BREAKER

designed for 2,300, 4,400, 6,600, and 13,200 volts for both classes of service. They furnish protection by disconnecting the load from the station when any disturbance occurs, automatically connecting the two again after a predetermined time. If it fails to clear, an attempt is made again, and if the overload still persists the circuit is locked open.

The apparatus itself consists of a number of standard relays operating in connection with an oil circuit-breaker, which is closed by a small motor. The complete equipment for indoor service in capacities up to 7,500 volts is mounted on a self-supporting steel framework. For voltages above 7,500 the panel is mounted remote from the breaker. The outdoor equipment is made in two varieties, one with both the panel and the oil circuit breaker mounted together in a weather-proof steel housing, and the other using an outdoor type of breaker with the relay panel carried in a housing mounted on the supporting framework of the breaker.

The apparatus used to make up these equipments and their method of operation are best understood by referring to Fig. 1, a typical wiring diagram. In practice the circuit-breaker is normally closed, the contacts of all relays except the reclosing relay *R*, being also closed. When a short-circuit or overload beyond the setting or overload relay *O* occurs, the latter operates with an inverse-time characteristic and trips out the oil circuit-breaker. The opening of the breaker closes auxiliary switch *B*, energizing the reclosing relay *R* and the notching relay *N*. After a definite time interval the former closes its contacts and starts the motor that recloses the oil-circuit-breaker. At the same time, the notching relay moves up a step, and will begin resetting as soon as the breaker closes. If the trouble has not cleared from the line by the time the breaker is closed, the overload relay will open it again, and the same cycle will be repeated, the notching relay moving up another step. If the trouble still continues the breaker will open a third time, and further automatic operation of the equipment will be prevented by the notching relay, which opens its contacts on the third step, and must be reset by hand.

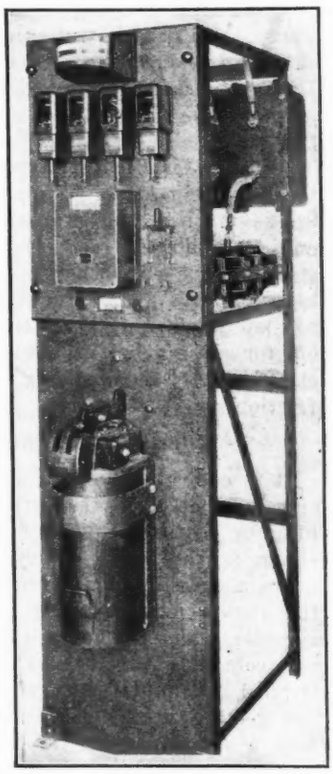


FIG. 2. AUTOMATIC RECLOSING CIRCUIT-BREAKER PANEL

The circuit shown by the dotted lines is a further protection, which may be incorporated if desired, and which locks the breaker open in case of severe short-circuits that are beyond the interrupting capacity of the oil circuit-breaker. By throwing the control switch *C* to the down position, the breaker is tripped, and cannot be closed with the switch in that position. This feature assures the safety of anyone inspecting the breaker and equipment. Throwing the control switch to the upper position resumes the automatic operation.

These equipments should be useful to power stations having isolated loads at widely dispersed points, the power for which is obtained either from tapping the main line or through a transformer substation. The reclosing feature insures continuity of service to the user of power, under normal conditions, and at the same time is a reliable protection to the apparatus of the main line in case of disturbance at the load. The automatic reclosing feature eliminates delays that might arise from the manual reconnection of the load. These equipments have been developed and placed on the market by the General Electric Company.

EDITORIALS

Extinguishing Electrical Fires

CARBON-TETRACHLORIDE, either in the commercial form or the material known under the trade name of Pyrene, has been used to a considerable extent by power-plant operators for extinguishing electrical fires. This type of extinguisher is the only one known that does not involve serious hazards of shock to the operator who might attempt to use it on an electrical fire. Undoubtedly, the recent newspaper reports that a large number of passengers had been overcome in the New York subway by gas generated from carbon tetrachloride used to put out a fire resulting from a short-circuit in a switchbox caused many power-plant operators to wonder as to the real danger of using this material as a fire-extinguishing medium. According to the first reports, phosgene and chloride gases had been generated from Pyrene (carbon tetrachloride) coming in contact with the arc and hot surfaces caused by the short-circuit. Without further delay or investigation the city authorities ordered the use of these extinguishers to be discontinued in the subway.

A subsequent report by General Lincoln C. Andrews, chief executive officer of the Transit Commission, recommends the continuance of the use of Pyrene extinguishers in the subways of New York City. The report points out that "There is no evidence that poisonous gas was generated through the application of carbon tetrachloride. Smoke and fumes generated by the fire resulted principally from burning insulation, paint and other substances. The vapor and fumes from the carbon tetrachloride were so diluted because of ventilation or drafts about the fire as to be negligible. A thorough search for a suitable substitute for carbon tetrachloride as a fire extinguisher in similar circumstances has yet disclosed none as good or better." Members of the United States Bureau of Mines reporting on the accident state: "That there were apparently no really serious cases resulting from the effects of possible toxic gases. That the symptoms given in the hospital records can all be accounted for by the known effects of gases resulting from the burning of insulating materials, rubber, varnish and paint. That the symptoms given are not characteristic of phosgene or carbon tetrachloride poisoning."

This report should allay to a large degree any misapprehension on the use of Pyrene as a fire-extinguishing medium. Undoubtedly there was a large volume of smoke and fumes given off by the three pounds of insulation that burned in the switchbox where the short-circuit occurred, and this, coupled with the excitement, might easily account for the passengers being overcome. Carbon tetrachloride gas is considerably heavier than air, and unless it were present in large quantities it would probably not rise more than two or three feet above the floor.

Much misunderstanding has apparently resulted from the use of the ordinary commercial grades of carbon tetrachloride as compared with the chemically pure material. It is generally conceded that the commercial grades may contain substances that will result in the generation of poisonous gases when applied to a fire or hot surfaces. On the other hand, with the chemically pure liquid the toxic gases produced are in such small quantities as to be practically negligible in anything but the most confined space.

What gases might be produced by applying carbon tetrachloride to the intense heat of a sustained electric arc has not been clearly established. If this data were available it would do much to relieve any doubts as to the possibilities of danger from this source. When chemically pure carbon tetrachloride is applied to the ordinary electric arc, the latter is quenched almost instantaneously; therefore there is little danger from gases being generated other than from the hot surfaces, and it is known that this does not produce toxic gas, except, possibly, in negligible quantities.

The operating officials are apparently between two hazards—that which may happen if an electric fire occurs where no suitable means is provided to extinguish it, and that due to the application of the only means that can be applied without danger from electric shock. The evidence seems to be so much in favor of the latter as to leave little doubt as to the good judgment of the engineers recommending the use of this fire extinguisher.

A French Super-Station

MERE bigness is not as common in France as in America. That is what makes such a structure as the Eiffel Tower seem particularly remarkable. The same is true of French power plants. None, heretofore, has been large in comparison with the two or three largest American central stations. But now there is fast nearing completion at Gennevilliers, just outside of Paris, a station whose size alone would attract widespread attention, even if it had no great individuality in the matter of design. The present installation of 200,000 kw., and the ultimate of 320,000, must rank it among the world's largest power plants.

But if it is the size of the station that first attracts attention, it is the uniqueness of the design that holds it. A bare summary of some of the high spots includes the preheating of furnace air, the use of ejector-type stacks, a regenerative system of feed-water purification combined with the use of deaërating apparatus and special distilling boilers, bleeding of the turbines in two stages for feed-water heating, recovery of generator losses by the feed water, and, finally, the use of 40,000-kw., 10-stage impulse turbines having a water rate of 9.45 lb. per kw.-hr. in spite of their simple construction. In view of these many striking features, it might be expected that this plant would go to extremes in the matter of steam pressure and superheat. Yet, from the European point of view, it has been conservative in these particulars.

Power feels fortunate in being able to give its readers a description of the Gennevilliers Station, written by an engineer familiar with both American and French prac-

tice, and one who has been in Paris for many months with the opportunity for close contact with the engineers responsible for the design and construction of this plant. The first installment, which appears in the present issue and deals with the general design, will be followed next week by a second describing the electrical equipment and the method of heat balance. These articles do more than describe; they give the reasoning that led to the adoption of certain features and make interesting comparisons with typical large plants in America and Great Britian. While, of course, recognizing that American and French problems differ in some respects, and hence require different solutions, American engineers may broaden their viewpoint on power-plant problems by studying each feature of this plant with the following two questions in mind: (1) Is this apparatus or arrangement the best possible in the light of French conditions? (2) To what extent could it be profitably used in this country?

Distribution, A Key to the Coal Situation

THE coal strike has now been in existence four months. Up to quite recently it excited little attention among the consuming public, owing to a lessened seasonal demand and the large stocks on hand. However, the Illinois massacre, intervention by the Government and a realization of approaching depletion of stocks, especially among the smaller industrial concerns, have all served to focus attention on the situation within the last two or three weeks.

One of the worst aspects of this has been the creation of panicky feelings among consumers—a harvest condition for profiteers and speculators. That they have hastened to take full advantage of the situation is reflected in the sudden rise of spot coal in certain localities, notably in the Western Kentucky fields, where the last week has witnessed a steady advance in price at the rate of a dollar a day. This is one of a number of districts that refused to abide by the Hoover agreement on prices.

While the administration has thus far made little progress in its efforts to reconcile differences between the miners and operators, it has, nevertheless, seized upon the key to the situation by controlling the distribution of coal. While Mr. Hoover lacks authority to compel operators to adhere to the price agreement, he can, and has, declared his determination to see to it that any operator intent on robbing consumers will find difficulty in obtaining cars.

Superheat with Higher Steam Pressures

LESS superheat than anticipated is said to have been obtained in certain new power plants designed for boiler pressures of over three hundred pounds per square inch. Perhaps the difficulties may be traceable to the properties of superheat not having been carefully considered. It is well known that the specific heat of superheated steam for a given degree of superheat increases with the absolute pressure. Few engineers have considered the influence of this property on power-plant design at very high pressures and superheats.

Prof. Knoblauch, the eminent German engineer, in a recent paper presented data from his latest research on the properties of superheated steam up to 426 pounds per square inch absolute, and up to about 650 degrees Fahrenheit total temperature. At 426 pounds absolute the instantaneous specific heat just above saturation was 0.94, while at this pressure and 200 degrees superheat it was 0.563; the mean specific heat up to 200 degrees Fahrenheit being 0.661.

Compare these values with the instantaneous specific heat at 255 pounds per square inch absolute—a common boiler pressure—where it is 0.725 just above saturation and 0.537 at 200 degrees superheat. The mean specific heat at 255 pounds absolute, up to 200 degrees superheat, is 0.587.

It will be apparent from these two mean specific heats that about one-eighth more heat must be added to each pound of steam at 426 pounds per square inch than at 255 pounds in order to obtain 200 degrees superheat. It will also be evident that additional heat must be furnished to the superheater to obtain this superheat. What does this involve in boiler design? Either more superheater surface or the superheater must be placed lower down in the boiler where the gases are hotter. Even radient-heat superheaters may be necessary. It must also be remembered that the saturated-steam temperature is also higher at higher pressures.

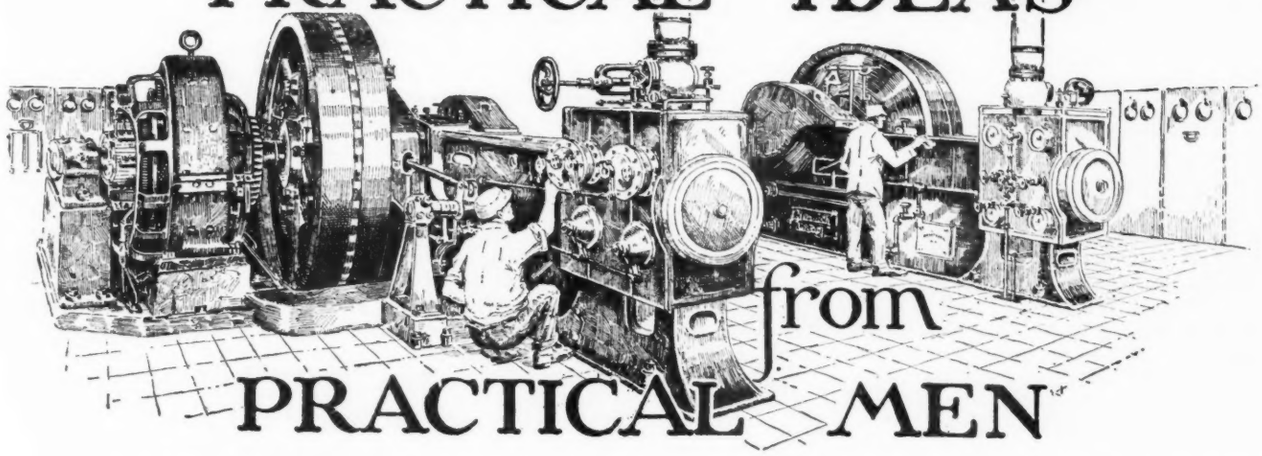
It is apparent, then, that this increase in mean specific heat introduces some new problems in boiler and superheater design that must be given attention.

It is not surprising, in view of the phenomenal development of the turbine, the new problems which it had to meet not only in speed and temperature stresses but in harmonic vibration, the difficulties encountered in the war period in obtaining proper materials and skilled labor, that there should have been some troubles. Intelligent and good-natured co-operation between the manufacturers and users of these machines is, however, working these problems out most satisfactorily. It will be in the interest of dependability if thermal efficiency is sacrificed slightly in the interest of security by less striving after close clearances and excessive blade velocities. A small reduction in the percentage of outage will compensate for the loss of a number of points in steam consumption and it will be easy when the wrinkles have been smoothed out on that basis to feel the way gradually to the point where the efficiency and dependability curves cross.

Protective relays are just as important as the equipment they are intended to protect, and may be considered to be even more so, since if they fail to function properly when the circuit or apparatus is in distress, serious damage may result. Unless some schedule is maintained for inspection and testing these devices, they are pretty sure of being neglected, since, unlike the main equipment, they may be inoperative and yet give no trouble until called upon to function.

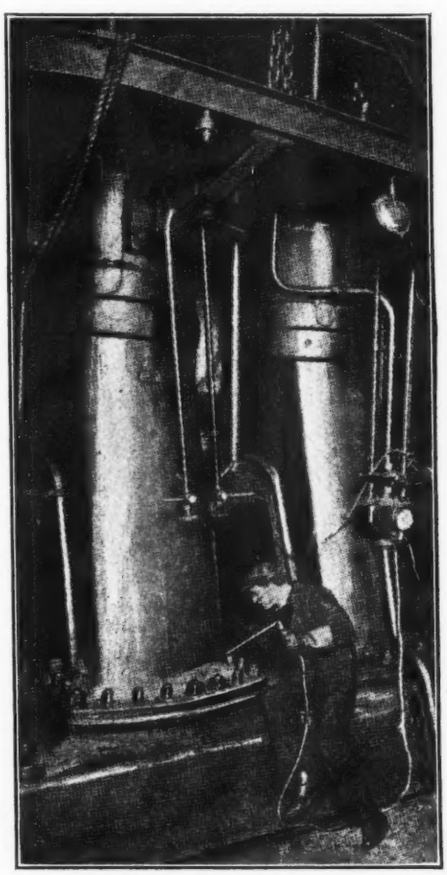
The United Fruit Company, Boston, Mass., has closed a contract for three motor ships with the Cammell-Laird and Co., England. These vessels, which are about 4,000 ton gross, will be propelled by electric motors. Power will be supplied by Camellaird-Fullagar opposed-piston Diesel engines. The question that come to all is Why was not the contract for the Diesel engines secured by American builders?

PRACTICAL IDEAS from PRACTICAL MEN



Welding Oil Engine Frame

One of the bolts holding the crankpin box to the big end of the connecting rod of a Diesel engine failed. This caused the box to open, bending and finally breaking the second bolt. The connecting rod and piston,



WELDING DIESEL ENGINE FRAME

freed from the crank pin, dropped and, wedging against one leg of the A-frame, broke it at the base flange.

To replace this A-frame would involve the expenditure of several thousand dollars, not to mention a long shut-down. After a full consideration, the management decided to try welding, and an electric arc-welding company undertook the task.

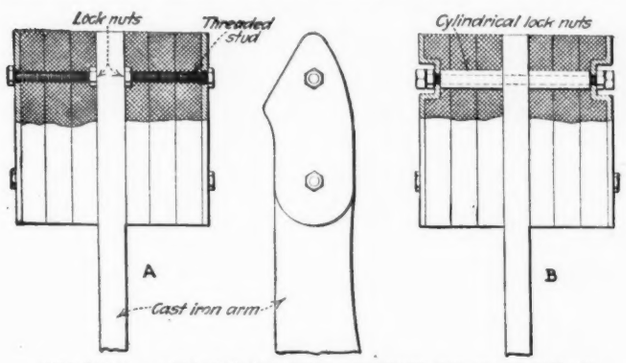
The fracture was cut away to form a V-shaped opening. The welder then preceeded to fill in this opening with the welding material. After the work was completed the engine was put into service, and is still operating without any signs of failure of the weld.

Manchester, England. FRANK MASON.

Improving Governor Weight Attachments

The governor of a poppet-valve engine is furnished with a pair of oscillating arms for shifting the eccentric which actuates the valves, as variations in the load or steam pressure call for an earlier or later cutoff. Blocks of lead are attached for weighting these arms.

In the original construction, the leaden weights were attached by means of ½-in. studs, which were locked to the cast-iron arm with two hexagon nuts, as shown at



ORIGINAL AND IMPROVED METHOD OF FASTENING WEIGHTS TO ARM

A. These studs were threaded from end to end. The weights were clamped to the arm by means of nuts on the ends of the studs, with ½-in. steel plates intervening as washers. On account of the small clearance between the weights and the sides of the chamber in which they oscillate, these clamping nuts were cut down to less than one-half the thickness of a standard ½-in. nut. Hence their clamping effect was somewhat deficient, and as a consequence the weights would shift on the studs with every throw of the arms, until eventually the threads would have enlarged the bolt holes in the soft lead.

To correct this, the engineer devised the method of fastening shown at *B*. Each stud is locked to the arm by means of two long cylindrical nuts. The outside

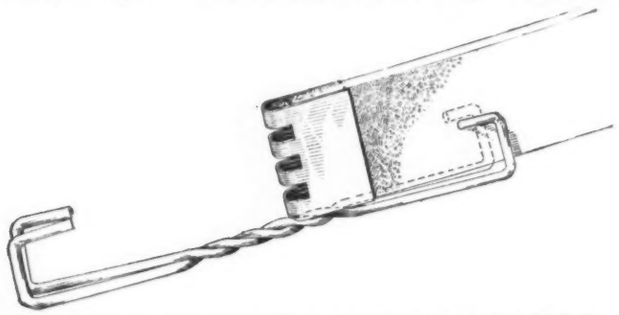
diameter of these nuts is ¾-in. The holes in the leaden weights are drilled so that the cylindrical nuts fit them snugly. Hollow bosses were provided in outer clamping plates, so that the ends of the studs could be secured with lock nuts.

This arrangement has entirely removed the trouble due to the enlargement of the holes and the consequent flopping of the leaden weights. A. J. DIXON.

St. Louis, Mo.

Clip for Holding Ends of Belt While Connecting

I have always experienced considerable difficulty in connecting the two ends of a belt when it is slung over a revolving shaft. Apart from the pull of the shaft, it requires considerable manouvering to hold both



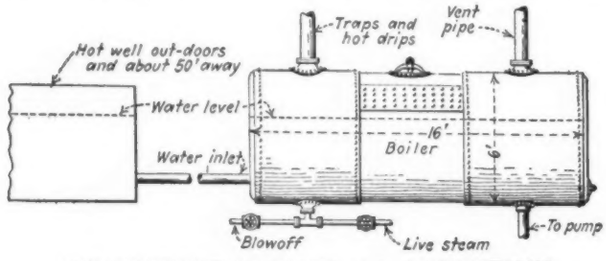
CLIP HOLDS ENDS OF BELT, WHILE PIN IS INSERTED

ends together with one hand while the rawhide pin is pushed into place with the other. In the illustration is shown a clip that is very useful for holding the ends of belts up to about 4 in. in width, above which it is usually considered more than a one-man job. The clip is slipped on one end of the belt before throwing over the shaft and on the other when both ends are brought together. It will be seen that the ends of the wires are bent inwards, so that the clip will slide easily on the belt, while a pull in the opposite direction tends to force the ends into the leather. After the pin has been slipped into place the clip is easily removed by drawing it off sideways. HARRY MOORE.

Montreal, Quebec, Canada.

Old Boiler Drum Used as Oil Separator

In the plant where I am employed we have an arrangement of boiler feed supply that might be of interest to those who have somewhat similar conditions. Our plant contains Corliss engines and steam



ARRANGEMENT OF DRUM AND CONNECTIONS

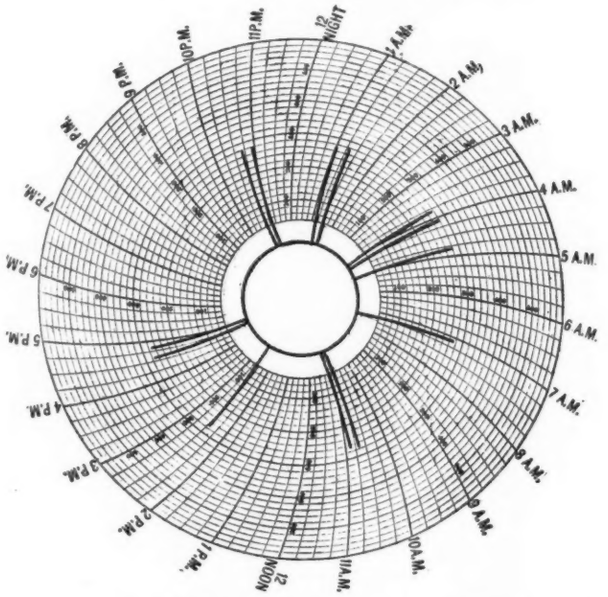
turbines, operating with jet condensers. The entire water supply is taken from the engine hotwell, as it is of somewhat higher temperature than the turbine hotwell. As the level of the water in the hotwell is above the turbine basement, we installed an old boiler shell as a separating tank. All traps and hot drips discharge into this tank. A connection from the hotwell maintains a constant water level in the tank, and a 6-in. vent pipe prevents the accumulation of pressure. There are about two barrels of cylinder oil used each month on these engines, and it all goes to the hotwell, but this separating tank has proved effective in removing this oil from the water, no trace of oil being found in the boilers. The tank is drained once each month and steamed out with live steam. Provision is also made for the reclaiming of the oil from the surface of the water in the tank. WALLACE JOHNSON.

Utica, N. Y.

Recording Thermometer Used as Counter on Ash Hoist

In the plant where I am employed, the ashes are shoveled from the pits into an ash car, which is pushed along the track to the bottom of the conveyor and dumped into a bucket and then lifted with an electric hoist to an overhead ash hopper.

As it was desirable to keep an exact account of the number of buckets of ashes taken out in a day's run, and as the accuracy of the record kept by the ash men



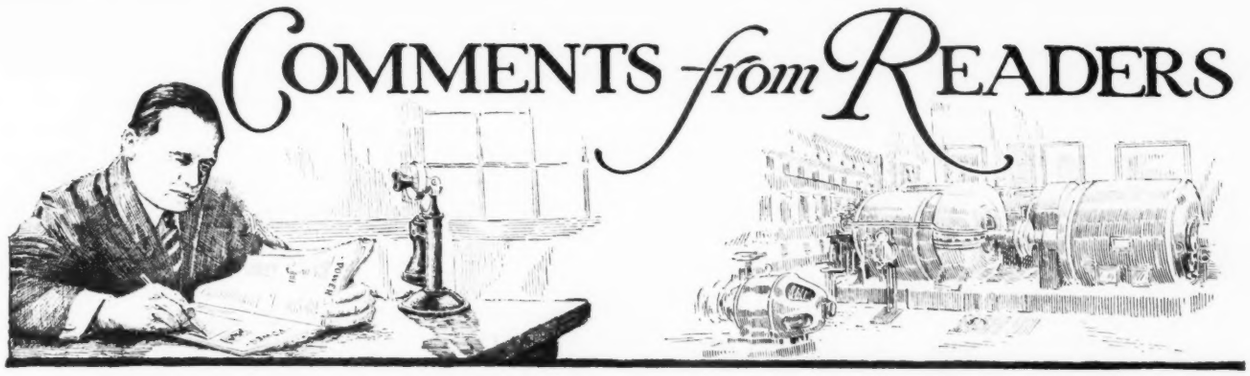
INSTRUMENT RECORDS NUMBER OF BUCKETS AND TIME OF REMOVAL

was often questionable, we decided to install an indicator or counter on the elevator that would record each time the bucket reached the top.

Having an old recording thermometer with a damaged tube, we decided to use the recording part of the instrument as a counter. The instrument was placed on the side frame of the drum that hoisted the bucket in such a manner that when the switch was closed to lift the bucket a small crank and lever would move the pen of the instrument over the chart about two inches, as shown in the cut.

In this way we have a correct record of the number of buckets and also the time of day or night they are taken out. H. WESTWOOD.

Lansing, Mich.



Finding Ammonia Leaks

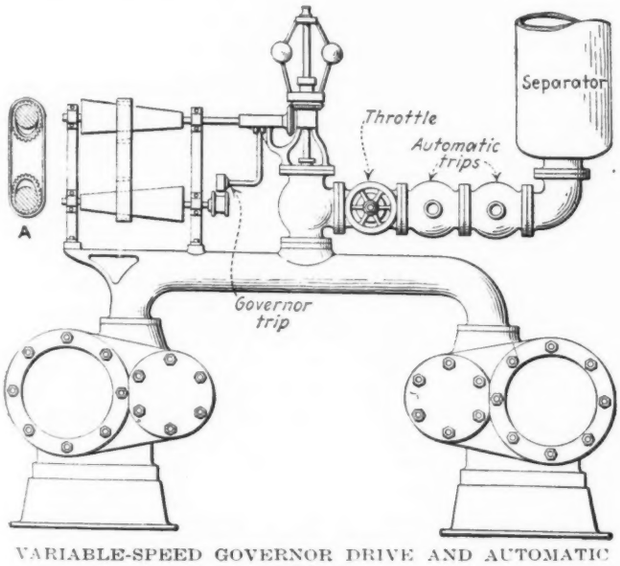
In the June 20 issue of *Power*, in the Question and Answer department, R. G. asked, "How can ammonia leaks in the refrigerating system be detected?"

The answer as given there was to use sulphur candles for joints to the atmosphere held near the suspected point of the leakage. The writer has found that by dipping a stick in muriatic acid or hydrochloric acid and holding the stick near the suspected point of the leakage, there would be given off a cloud of fumes or vapors. It is a safer method than to have a light about ammonia leaks. CHARLES SEAMAN.

Davenport, Iowa.

Why Did the Engine Stop?

In the operation of a twin variable-speed engine of 300-hp., speed variable from 75 r.p.m. to 250 r.p.m., equipped with an automatic stop operated by the flywheel, also one operated from the crankshaft, and in addition a trip operated by the governor belt, the engine stopped dead when the transformer broke and came from under the cone belt of the variable-speed mechanism. The transformer referred to is an endless belt a few inches longer than the circumference of the large end of the cone, shown in section at *A*. The belt is triangular in cross-section and transforms a tapering surface to a parallel one on which the cone drive belt runs. Guides to hold the belt at any desired point are moved along fixed rods by a screw and handwheel.



VARIABLE-SPEED GOVERNOR DRIVE AND AUTOMATIC TRIPS

The cone belt and transformer were both broken. It is not known which broke first as the engineer was not near, but the supposition is that the transformer let go first and in leaving the pulley broke the cone belt. Now when a cone belt breaks, we expect the governor to stop with the valve in open position as in starting up. But in this case the engine came to a dead stop with the throttle wide open. Not one of the automatics had operated, showing conclusively that the engine did not speed as the three automatic trips were found to be in perfect condition, and after putting on another transformer and repairing the cone belt, the engine was started as usual. Can some reader of *Power* tell me why the engine did not speed? GEORGE W. CLARKE.

Mechanicsville, N. Y.

Economic Factors in Power Development in Ontario

In the June 27 issue the article on the Queenston development of the Hydro-Electric Commission of Ontario treats of the engineering features, but to a large degree neglects the economic factors and the growth of the Commission that forms the basis of the whole structure of electric-power development in Ontario. Canada is not a great coal-producing country. Although there are deposits in Nova Scotia and in some of the western provinces, Ontario must depend on imported coal. This means that after paying transportation and duty, to get coal from the United States is cheaper and easier than to use their own. The serious consequences of a lack of coal occasioned by a failure of the American supply was evidenced in the winter of 1918-19, when in the dead of winter it was necessary to close down mills and factories in many of the cities that the people might have coal to heat their homes. Nature certainly has not bestowed upon Ontario the great gifts of coal, but she has given that province waterfalls, wonderful for their extent and location.

Canada occupies a unique position as regards both potential and developed waterpower. The per capita power now developed is larger than in all the other countries except Norway. No country enjoys to a

WATER POWERS OF EUROPEAN COUNTRIES, UNITED STATES AND CANADA

Country	Area in Square Miles	Population	Hp. Available	Hp. Developed
United States	2,973,890	105,000,000	28,190,000	9,000,000
Canada	3,600,000	9,000,000	18,803,000	2,000,000
France	207,500	39,601,500	5,587,000	1,100,000
Germany	208,800	64,926,000	1,425,000	618,100
Norway	124,130	2,391,000	5,500,000	1,120,000

greater degree the benefits of cheap dependable hydro power, and no country has had the benefits more universally applied for municipal, industrial and domestic use.

Numerous small concerns have been organized and have developed some of the smaller waterfalls throughout the Dominion. But what has grown to be the greatest hydro-electric company in the world took root at a small meeting in the town of Berlin (now Kitchener) in 1902, a meeting attended by representatives of municipalities, boards of trade, trade unions and public-spirited citizens. The most gratifying aspect of this concern is that it is the sole property of the people. The meeting at Berlin selected a committee to work out the method of procedure. This committee was to wait upon the Legislature of the province of Ontario to ask for necessary legislation and to devise ways and means to secure a supply of power to the industrials of that part of the province. A law was then enacted which empowered the municipalities to organize themselves and to acquire water powers and transmit electricity on their own behalf and distribute it in their several municipalities.

Appointment of the Commission

Immediately after the passage of the act in question, the municipalities of Toronto, London, Brantford, Stratford, Woodstock, Ingersoll and Guelph exercised their power and appointed a commission to inquire into the best method of developing power for their needs and the cost. This commission, composed of Sir Adam Beck and four others, made its report in 1905. It became evident from the discussions that followed the publication of this report that certain serious difficulties of procedure were inherent in any plan that depended for its final accomplishment upon purely municipal initiative. A new commission was appointed and finally, after a number of reports, discussions and some public agitation, the Hydro-Electric Power Commission of Ontario was formally created by statute, on May 14, 1906, its powers, however, being revised on April 20, 1907.

The powers conferred on the Commission were to investigate and report upon any and all hydraulic, hydro-electric and other power undertakings throughout the province; to inquire into and report upon the power and lighting needs of the province and upon the authority of the Lieutenant Governor in Council; to purchase, lease, expropriate or otherwise acquire lands, water powers and other privileges; to purchase, lease, expropriate, construct or otherwise acquire generating, transmitting and distributing plants and works and to operate the same; to expropriate power product of, or to contract with any person, firm or corporation for a supply thereof; and to enter into all necessary arrangements with Ontario municipalities or other corporations including railway and distribution companies, for the fullest exercise of these powers, with the object of providing adequately for the supply of the power and lighting needs of the province at the lowest possible cost. Authority is also given to the Commission to control the rates charged by the municipalities on the sale of power purchased from it.

When the municipalities organized and applied to the Commission for a supply of power, the Commission with these extraordinary powers had no difficulty in securing co-operation on the part of those companies generating power in the district from which the appeals reached it. There were three companies operating in the Niagara district—the Ontario Power Co., the Electrical Development Co. and the Canadian Niagara Power Co. At this time the Commission had applications from sixteen municipalities for 20,000 hp. A contract was made with the Ontario Power Co. for 100,000 hp. at $9 per hp.-year. The municipalities took the matter up and fourteen of them entered into contract to the extent of 30,000 hp.

The Commission's contract with the Ontario Power Co. called for not less than 8,000 hp. and as much more as required up to 100,000 hp. for a term of ten years with provisions for three extensions for additional periods of ten years each, at the price of $9.40 per hp.-year, up to 25,000 hp. and $9 per hp.-year if the quantity taken exceeds 25,000 hp. The power to be delivered by the Ontario Power Co. to the Commission at Niagara Falls at 12,000 volts and the period covered a 24-hour continuous service.

The municipalities pay the Commission for the power on the following basis: (1) The contract price of the Ontario Power Co. at Niagara Falls, plus (2) four per cent per annum upon that part of the construction cost which is properly applicable to each participating municipality, plus (3) an annual amount sufficient to create a sinking fund which in thirty years shall pay for that portion of the construction cost which is applicable to each municipality, plus (4) that proportion of the line loss and the general operating and maintenance charges which are properly applicable to each municipality.

The annual rate payable by several of the municipalities has been reduced to the following: Toronto, $18.10 per horsepower per annum; London, $23.50; Hamilton, $17.50; St. Mary's, $29.50. These rates are for power delivered at the municipal substation at 13,000 volts. Each municipality assumes the responsibilitiy for acquiring or providing the necessary local distributing system and the maximum cost to the consumer on the rates given will be the prices stated plus the different local distributing costs.

Effects of Commission Control

The criticism of the Hydro-Electric has been that it interferes with private interests. To prove the fallacy of this statement, let us take the case of the City of Ottawa (to cite only one such case). In that city prior to 1901 the following rates were charged by the Ottawa Electric Co.: House lighting, 15c. per kilowatt-hour; street lighting, $65 per arc lamp per annum; motive power, $40 and upward per horsepower per annum. During this time the company paid no dividends. The Commission contracted in 1907 for the purchase of power from the Ottawa & Hull Manufacturing Co. for a period of ten years, at the price of $15 per hp.-year, for the sale of this on the same terms to the City of Ottawa. Prior to this time the city's right to purchase current direct from a power company had been successfully assailed in the courts, and it was therefore left with a distributing plant on its hands but without any source of supplies. As a result of the efforts of the Commission the city has, since 1907, been able to secure an abundant supply of power at a price that has permitted the continuance of the schedule of prices as follows; House lighting, 7½c. per kilowatt-hour, or a reduction of 50 per cent on the 1901 prices; street lighting, $45 per arc lamp per annum, or a reduction of 31 per cent; motive power, $25 per hp.-year, or a reduction of 37½ per cent.

The reduction in prices has so stimulated consumption that together with the increased demand that accompanied the growth of the city, the business of both the city and the Ottawa Electric Co. has greatly increased, the company now pays 5 per cent dividends on its outstanding capital stock of $1,000,000, and is adding a surplus to its reserve account. Before the city electric-light plant began operations, the Ottawa Electric Co. stock was selling at between 60 and 70; now it sells at 160. The same thing has taken place in other centers where the Hydro-Electric Power Commission has sold power. Instead of forcing the private companies out of business, it has increased the value of their holdings and in almost every case increased dividends.

Had this matter been left exclusively in the hands of private companies, their tendency would have been to get the easiest market for their output, by including manufacturers to settle within easy distance of Niagara Falls and by selling in large blocks to large users. Under the policy of the Commission the benefits are being distributed throughout the province to large and small users alike, thus contributing to a well-balanced and general development rather than an abnormal expansion in one district at the expense of others.

The project was launched by fourteen municipalities which expected to use an aggregate of approximately 30,000 hp. Today hydro power is supplied to 260 municipalities, townships and many large industries, and exports 70,000 hp. to the American side.

The demand for the Commission's power increased to such a degree that in 1914 plans were made for the Queenston-Chippawa development. At this time the Hydro had grown to 433 miles of 110,000-volt lines, 800 miles of 2,300- to 46,000-volt lines and 1,500 miles of telephone lines and 63 substations.

Muscle Shoals, Ala. T. G. WOOD.

Filing Information

Commenting on the foreword in the June 27 issue on "Filing Information," I have had a system in use for about ten years that has proven satisfactory and convenient. It is clearly illustrated by Figs. 1 and 2.

Upon one side of the card I index published articles as in Fig. 1. The other side is ruled vertically and horizontally for plotting diagrams or curves. The cards are also large enough for the column width of prints

Power Plants.

Preliminary Study for 300000 HP Hydro El. Devel't	C.9-10-18-245
Puntledge Hydro-Electric R.9-27-18-349	R.9-20 " 312
Hydro-El. Wh. Salmon Riv. Wash.- Wood Stave Pipe-13½ Dia.	R.10-11 " 347
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Low-Head Hydro-Electric Cyan Rapids, Minn.	M.7-16-18-118
Pittsford Vt. " Head 40'	" " 1-15-14
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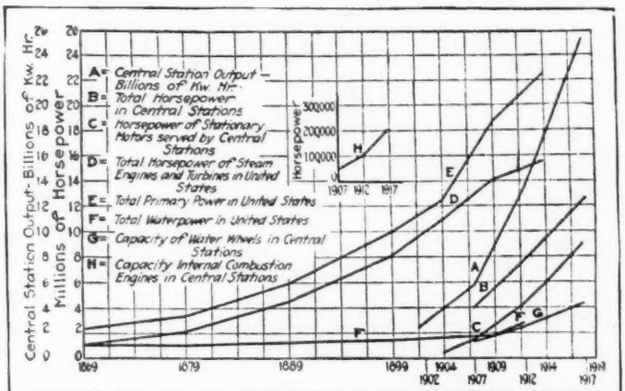
Test of with Motor Generator for Brake	" 4-20-16-780
Race.- Steam & Water - 4000 HP. Cond. 1' HPH.	C-6-21 " 554
Cooling of Water for - Tests.	Rome - Dec. - 17
Hydro-Electric - Cologne Spain	C-5-29-18-534
Report - Forms for Power-House	P-11-19 " 798
"Natural Steam" Turbine Plant - Lardarello, Italy	" 12-24 " 995
Charts for Calculation of Efficiency & Fuel Costs	" 3-4-19-346
Muscle Shoals, Ala. - US Nitrate Plant No 2	" " 25 " 424
Appalachian Power System	" " " 498
Growth of El. Lt. & Power Industry over	" 4-22 " 627
Brule River. Hydro-Electric - Florence Wis. - Hd 60' -	" 6⅔ " 842
Ice - Handling at Holtwood Hydro-El. Sta. Susq. River	" " " 250
Data on U.S. Nitrate Plant No 1 - Sheffield Ala.	" " 24 " 946

FIG. 1. THIS SIDE OF THE CARD IS RULED AND USED FOR INDEX


Central Station Output - Billions of Kw. Hr.
Millions of Horsepower
A = Central Station Output - Billions of Kw. Hr.
B = Total Horsepower in Central Stations
C = Horsepower of Stationary Motors served by Central Stations
D = Total Horsepower of Steam Engines and Turbines in United States
E = Total Primary Power in United States
F = Total Waterpower in United States
G = Capacity of Water Wheels in Central Stations
H = Capacity Internal Combustion Engines in Central Stations
Horsepower
1869
1879
1889
1899
1902
1904
1907
1909
1912
1914
1917
1918

TREND OF POWER INDUSTRY IN THE UNITED STATES
COMPILED FROM SEVERAL SOURCES

TABLE I. EFFICIENCY OF POWER PRODUCTION IN TEN STATES

Results for four months, February, March, April and July, 1919, as compiled by U. S. Geological Survey, Division of Power Resources. Computed on the basis of four barrels of oil equals one ton of coal and 20,000 cubic feet of gas equals one ton of coal.

P-3-9-20-386

State	Current Produced Millions of Kw.-Hrs.	Fuel Used Thousands of Tons of Coal or Equivalent	Efficiency Kw.-Hrs. per Ton
New York	1,124	1,420	792
Pennsylvania	958	1,610	595
Illinois	784	1,311	597
Ohio	776	1,282	605
Massachusetts	403	533	756
Michigan	390	497	787
New Jersey	308	459	671
West Virginia	237	321	738
California	222	310	716
Indiana	213	585	364
Average			662

Month	Current Produced Millions of Kw.-Hrs.	Fuel Used Thousands of Tons of Coal or Equivalent	Efficiency Kw.-Hrs. per Ton
February	1,834	3,124	586
March	1,842	3,175	580
April	1,718	2,894	594
July	1,929	3,032	636
Total or average	7,323	12,225	599

FIG. 2. OTHER SIDE USED FOR CURVES OR CLIPPINGS

from technical papers, and they are a convenient size to carry in the pocket.

I use them also to record and file special formulas, computations, tables and other data. J. W. PEARL.

Chicago, Ill.

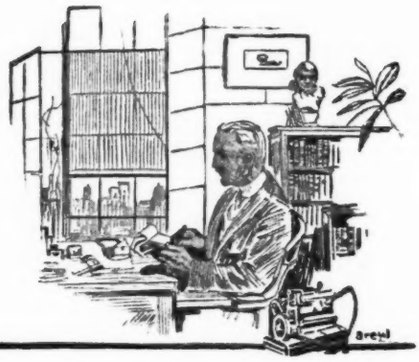
Coal Versus Oil

In the July 11 issue, Henry D. Jackson discusses "Comparative Tests on Coal- and Oil-Burning Boilers," which appeared in the June 13 number of *Power*. Mr. Jackson contends that the fixed charged such as interest, maintenance, taxes and depreciation, should be taken into account in the comparison of the cost of steam as generated in coal-burning boilers and in oil-burning boilers, and that since these fixed charges are somewhat larger in the case of the oil installation, the balance would perhaps be turned in favor of coal. I think fixed charges should by all means be taken into account, although in this case they are small compared to the operating costs. The purpose of my article, however, was to present a comparison of operating costs only.

While the efficiency of the coal-burning boiler is rather low, it is not far from the average of similar boilers under similar conditions. When burning oil, there is one important advantage to be borne in mind—sudden fluctuations in load can be met with less loss of efficiency than is possible when burning coal.

New Haven, Conn. S. A. SMITH, JR.

QUESTIONS AND ANSWERS



Water Injection Increases Capacity of Semi-Diesel Engine

Why will a semi-Diesel engine cylinder of a given stroke and bore develop more power with than without water injection? L. G.

The introduction of water into the cylinder during the scavenging part of the stroke serves to lower the temperature of the hot piston head and cylinder walls. The air on entering the cylinder does not heat up so much. A greater weight of air will then be trapped in the cylinder and, since the power output depends upon the weight of air present to be combined with the fuel, the water enables the engine to burn more fuel and develop more power.

Separate Steam and Exhaust Ports of Duplex Pump

Why are the steam cylinders of duplex pump provided with separate steam and exhaust ports at each end of the steam cylinders? N. R. C.

Separate exhaust ports are placed farther than the steam ports from the ends of the cylinder so the exhaust may become covered by the piston just before completion of an exhaust stroke. The exhaust steam which is thus trapped in the end of the cylinder is compressed and acts as a cushion to prevent the piston from striking the end of the cylinder. The steam passages are always in communication with the cylinders and, in some pumps, communication is provided between the steam and corresponding exhaust passage controlled by a valve, called a cushion valve, for regulating the cushioning effect by permitting the escape of more or less of the compressed exhaust steam from the end of the cylinder, through the steam port and cushion valve, to the exhaust port.

Slip of Pump

What is the slip of a pump, and how can the slip of a boiler-feed pump be determined? A. W. R.

Slip is the percentage of piston displacement that is not realized, owing to defective piston packing, leaky stuffing boxes or valves, the delayed closing of the valves or the amount of air carried into the pump body by the water.

In a new pump that handles water reasonably free from air, the slip rarely exceeds 2 per cent of the piston displacement when the pump is operated at normal capacity, and in packed pumps, where there is no leakage past the plunger or piston, the percentage of slip is less. Frequently, pumps handling large quantities of water have shown slips of ½ per cent, no slip, or negative slip; that is, the delivery of water has been in excess of the piston displacement from the tendency of the water to flow after the plunger has stopped. With large pumps it is difficult to determine the slip accurately as there is no absolutely reliable method of measuring large flows of water, and the error of measurement is lakely to be more than the slip in a pump in good condition.

Slip depends on the condition of the pump, the pressure and the speed, hence for a given case the percentage of loss depends mainly on the speed.

As slip equals leakage divided by displacement, then with the rate of leakage constant it is evident the percentage of loss increases with a decrease of displacement; that is, if the slip at full capacity is 2 per cent, at one-half capacity it will be 4 per cent, and with sufficient reduction of speed a point will be reached when the slip is 100 per cent and the pump does not discharge any water at all. Hence, to test the approximate percentage of slip of a small pump, the discharge valve is closed and sufficient steam pressure is admitted to produce the normal water pressure; then the number of strokes per minute multiplied by 100 and divided by the number of strokes made in regular operation will be the slip expressed as a percentage of piston displacement at the normal speed.

Relative Time Required to Empty Boiler

Can a boiler be emptied of water more quickly discharging through a blow-off valve when the boiler is under 100 lb. steam pressure, or when the boiler is filled to the same level with cold water with the manhole cover removed to admit atmospheric pressure? A. B. D.

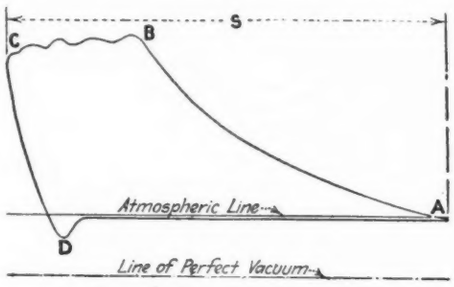
When discharging under atmospheric pressure, the velocity of flow will be due only to the head of water. If the steam pressure is maintained at 100 lb. gage, the velocity of flow will be due to the head of water plus 100 lb. pressure, or about 122 ft. total head. Calling the average head of water 3 ft. in each instance, the velocities would be in the ratio of $\sqrt{3}$ to $\sqrt{122+3}$, or about as 1 to 6.5, and the times required would be in the inverse ratio. This assumes that in each instance discharge from the blow-off valve is directly into the atmosphere. If the discharge from the boiler under steam pressure takes place into a blow-off tank in which the hot water bursts into steam, the expansion might be so restrained that the back pressure on the boiler blow-off valve would be considerably above the pressure of the atmosphere. In such a case the hot water would burst into steam at a reduced pressure and the whole final discharge to the atmosphere might consist only

of steam at reduced pressure, and thus discharging through an aperture no larger than the boiler blow-off, the weight of steam discharged in a given time might be no more than the weight of cold water that could be discharged under atmospheric pressure, or in that manner, longer time might be required to empty the boiler under 100 lb. gage pressure than when filled with cold water under atmospheric pressure.

Indicator Diagram from Air Compressor

How does an indicator diagram show the events in operation of an air compressor? C. R.

An air compressor diagram is similar in general form of outline to one taken from a cut-off engine, but the operations of admission, expansion, exhaust and compression shown by one are the reverse of those shown by corresponding lines of the other. Referring to the



AIR COMPRESSOR DIAGRAM

illustration of a compressor diagram, *S* represents the volume displaced by a stroke of the piston; *AB* is the compression line; *BC*, the delivery line; *CD* the re-expansion line; and *DA* the admission line. Starting with the piston at *A* and the cylinder filled with air, the pressure of the confined air rises as its volume is reduced by movement of the piston until a pressure *B* is obtained, somewhat higher than necessary for opening the discharge valve. Continuing its motion from *B* to the end of the stroke, the piston forces the compressed air into the receiver. The wavy line *BC* is due to the fluttering of the discharge valve and inertia of the indicator parts. Upon completion of the stroke at *C*, the pressure of air in the receiver closes the discharge valve, leaving the clearance space filled with compressed air. Then as the piston returns toward *A*, the compressed air in the clearance space expands until a pressure below that of the atmosphere is reached, as at *D*, when the suction valve opens and free air flows into the cylinder until the piston arrives at *A*.

Throw of Eccentric Depends on Eccentricity

What would be the effect on an engine valve gear if ¼ in. were cut off from the face of the eccentric? T. E. M.

The throw of the eccentric and movement of the valve gear with respect to the piston of an engine depend on the angular position of the eccentric and the eccentricity or distance the center of the eccentric is from the center of the shaft. A change of the diameter or width of face of the eccentric would make no difference, provided the eccentric strap were made to fit the eccentric to obtain smooth wearing surfaces and the eccentric rod were made of the same length, measured from the center of the eccentric to the center of the eccentric-rod pin.

Governor Pin on Corliss Engine

For starting a Corliss engine, why is it necessary to have the governor raised with the collar supported on the starting pin, and why will the engine run away if the belt breaks with the starting pin left in place? H. M.

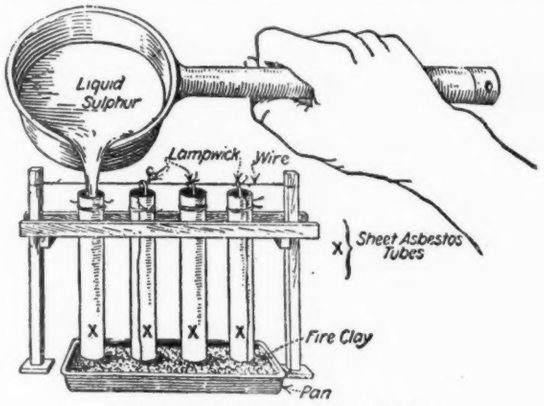
When the governor pin is out, the engine cannot be started from rest because the governor is down so low that the safety cams prevent the steam valves from being picked up. When the governor is raised to a position in which it is supported on the starting pin, the safety cams become moved around to a position that permits the valves to be picked up. Then with the throttle valve open and enough steam pressure for moving the piston, the engine can be started fast enough to carry the crank over the center, and the engine will continue to move faster until cut-off comes into action.

Should the governor belt break with the starting pin left in, the governor could not fall to a low enough position to bring the safety cams into a position that would prevent the valves from being picked up, as when starting up, and, unless the load chanced to be very much in excess of normal, the engine would run away.

Preparing Sulphur Sticks and Candles

How are sulphur sticks and sulphur candles prepared for locating leaks in a refrigerating system? J. L. S.

Melt the sulphur by placing it in a flat-bottomed can or pan heated to about 250 deg. F. Sufficient heat usually may be obtained by placing the vessel in direct contact with a hot steam pipe or engine steam-chest cover, or in a boiler uptake. If the melting is done over a fire or flame, the vessel should be supported on an iron plate to prevent overheating and ignition of the sulphur. For making sulphur sticks, twist together three or four strands of candle wick. Cut it up into lengths about 12 in. long, dip these into the molten sulphur for a few minutes and withdraw to cool in form



MOLD FOR SULPHUR CANDLES

of a rough candle. If candle wick is not at hand, very good sulphur sticks can be made by dipping splints of soft wood into the molten sulphur.

Better forms of candles are made in molds. A candle mold is readily improvised as shown in the sketch. Sheet asbestos is rolled up into tubes *X*, *X*, that have their lower ends packed in fireclay and with the lamp wick stretched through the tubes. The tubes are filled with molten sulphur as shown. When the sulphur has cooled, the candles are in convenient form for use with or without the asbestos covering.

Starting Equipment for Slow-Speed Direct-Connected Synchronous Motors*

By THEO. SCHOU
Chief Engineer, Ideal Electric and Manufacturing Company

THE application of direct-connected synchronous motors to compressors has become more and more general for the following reasons: The slow-speed synchronous motor is well adapted to start and pull into synchronism when connected to a compressor load. The slow-speed synchronous motor is highly efficient, therefore the direct-connected unit shows decided improvement, as to economy of operation, over the belted type; depending upon the type of compressor, the necessary flywheel effect for satisfactory operation may be incorporated in the rotor of the slow-speed synchronous motor, thus eliminating auxiliary flywheel, which means both saving in space and cost of the equipment.

As will be seen later, the inherent characteristics of the slow-speed synchronous motor make it both feasible and desirable to throw it direct on the line, thus eliminating both auto-transformers and tandem switches, besides making the operation of starting both simpler and safer.

Owing to the high impedance inherent in slow-speed 60-cycle motors, the inrush kilovolt-amperes at full voltage is by no means prohibitively large; in fact, it is no higher than the inrush of current for high- or medium-speed machines when started on the low-voltage taps of auto-transformers.

Slow-speed synchronous motors are advantageously and effectively designed to be thrown directly on full-line voltage and to give sufficient starting torque as well as high pull-in torque, and at no time during the starting period will they draw more current from the line than high-speed motors would when starting on low-voltage taps of compensators.

Fig. 1 shows the kilovolt-ampere inrush in percentage of normal at various applied voltages for different speeds of 60-cycle synchronous motors. These curves are based on a normal motor capacity of 300 kva. and terminal voltage not to exceed 2,200 volts. For larger motor capacities the

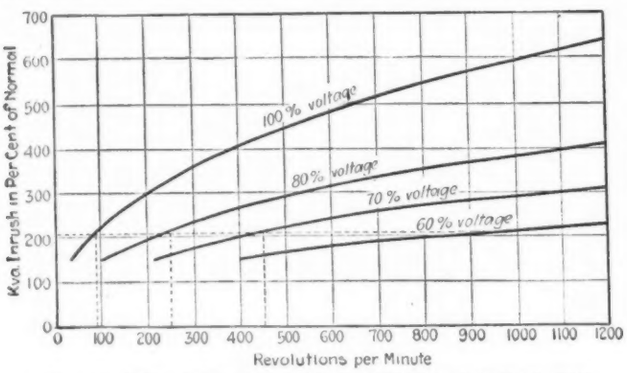


FIG. 1. PER CENT KILOVOLT-AMPERE INRUSH FOR SYNCHRONOUS MOTORS OF DIFFERENT SPEEDS

kilovolt-ampere inrush values will be somewhat lower; for smaller motor capacities they will be somewhat higher. Note that a 90-r.p.m. synchronous motor thrown direct on the line will draw no more current than a 257-r.p.m. motor started on the 80 per cent tap, than a 450-r.p.m. on the 70 per cent tap, or a 900-r.p.m. on the 60 per cent tap, as indicated by the dotted lines.

Fig. 2 shows the kilovolt-ampere inrush, in percentage of normal, which slow-speed 60-cycle synchronous motors at various capacities and speeds draw when thrown directly on full-line voltage. It should be understood that both these curve sheets give approximate values—test values may vary 10 per cent above or below.

*Abstract from a paper, "Present Status of the Synchronous Motor for Direct Connection to Compressors," presented at the Spring Meeting of the American Society of Refrigerating Engineers, Detroit, Mich., 1922.

At the present time slow- and high-speed synchronous motors are started in the same way and with the same starting equipment, which involves auto-transformers and tandem switches. To the writer's mind this is both wrong and inconsistent. Why use auto-transformers and tandem switches when they are not needed? Why buy something that represents a dead capital investment? Why install unnecessary equipment that needs care and attention and

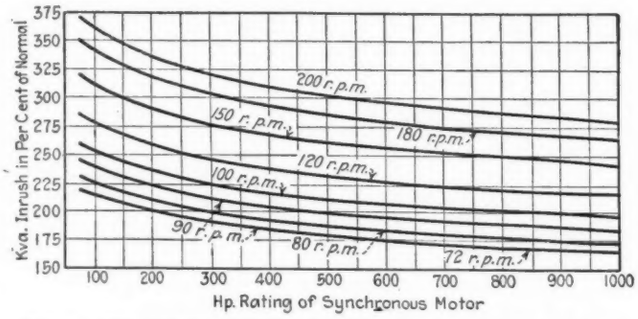


FIG. 2. PER CENT KILOVOLT-AMPERE INRUSH FOR SLOW-SPEED SYNCHRONOUS MOTORS OF DIFFERENT CAPACITIES AND SPEEDS

may cause breakdowns? Not only are parts of the present starting equipment unnecessary, but they are also undesirable from an operating viewpoint when starting slow-speed synchronous motors direct-connected to the load.

Anyone who has noticed the starting of a large synchronous motor belted to its load, has seen the violent flapping of the heavy belt when the motor was disconnected from the low-voltage tap of the auto-transformer and thrown on full-line voltage. If the alternating-current ammeter is watched when the tandem switches are manipulated it will be seen that the needle oscillates violently, indicating heavy current fluctuations.

Consider then, that if the motor starts under heavy load, its speed is bound to lapse during the time interval when it is disconnected from its source of power, causing even more disturbance. Obviously, the throwing over from the low-voltage taps to full-line voltage resembles very much the "sledgehammer method," and as the torque of the motor increases as the square of the applied voltage, this sledgehammer blow is by no means gentle. For instance, if the motor is started on the 50 per cent tap, the force or the torque of the motor will be quadrupled when full-line voltage is applied.

Consider a direct-connected slow-speed synchronous motor connected to an ammonia or air compressor. In this case there is no belt to ease off the "sledgehammer" blow. "It seems to me that something must give," said a prominent refrigerating engineer, who is inclined, for this reason, to specify belted motors for his installations. He is prejudiced against the "sledgehammer method" in the case of direct-connected synchronous motors. Due credit should be given this engineer for his keen sense of observation, for he has considered "the human element," the operator, who judges or guesses the right moment or the right speed of the motor when he can throw it over.

In order to eliminate this trouble, the author has proposed a modified starting equipment, which may be full automatic, semi-automatic or manually operated. The full-automatic unit control consists of an automatic oil switch with overload relays and low-voltage release, an automatic field switch, which closes when the motor is up to a certain speed, and push-button control located on the board or, if desired, at a convenient place near the valves of the compressor. The full-automatic control has already been ap-

plied to several installations and has proved itself capable of solving this problem in a most economical way, to the benefit of all concerned.

Fig. 3 shows a wiring diagram for a full automatic control for starting synchronous motors. Switch No. 1 is a manually operated, two-pole knife switch, which controls the direct-current circuit for excitation of the field of the synchronous motor. Switch No. 2 is a manually operated two-pole knife switch, to control the secondary circuit of the transformer which furnishes power for the operation of the alternating-current magnetic switches which are mounted on the starter.

A is a magnetic switch, the coil of which is energized

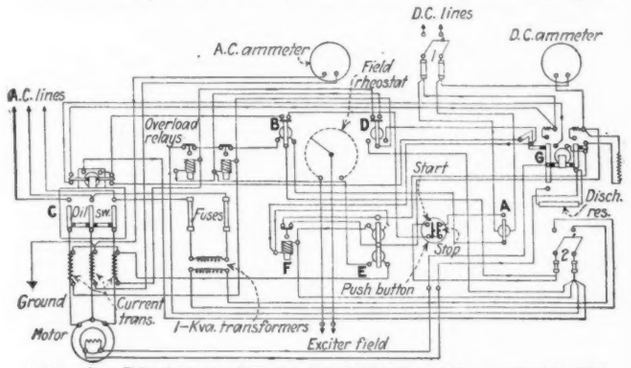


FIG. 3. DIAGRAM OF CONNECTION FOR AUTOMATIC SYNCHRONOUS-MOTOR STARTER

with direct current. Its contacts are in series with the alternating-current circuit which energizes the alternating-current magnetic switches.

B is a magnetic switch which directly controls the alternating-current circuit which operates all other alternating-current magnetic switches on the starter. The coil of this switch is energized by the alternating-current circuit.

C is the magnetic oil switch which connects the alternating-current windings of the synchronous motor to the line.

D is a magnetic switch which operates to short-circuit the overload-relay windings during the starting period of the motor.

E is a balancing relay with two excitation coils. The upper coil is of constant excitation, while the lower coil is excited by the current transformers and is, therefore, excited in proportion to the inrush of the motor at starting. When this inrush has died down to an amount so that the upper coil becomes stronger than the lower coil, then the relay operates to close the direct-current excitation to the field through switch *G*. The balancing feature of switch *E* is regulated by a setscrew which operates to change the air gap and, thereby, the magnetic pull.

F is a time-limit relay, the switch contacts of which are in parallel with the contacts of governing relay *E*. In case relay *E*, for some reason, should not operate after a predetermined time, due to a burned-out coil or otherwise, the time-limit relay *F* will operate and throw the direct-current excitation on to the motor.

G is a direct-current magnetic switch which in its running position connects the direct current to the field of the motor. Switch *G* in its off position or with its one lower contact closed, throws a discharge resistance on to the field of the motor. *G* in its on position disconnects the alternating-current excitation to relays *D*, *F* and *E* and makes these relays inoperative.

To start and stop the motor, push buttons may be connected in multiple so that one may be on the panel, while another one may be mounted on the frame of the motor close to the operating valves of the compressor. This enables one man to start the motor and operate the valves of the compressor at the same time. The buttons spring back into position immediately after being released. The button shown in the open position on the left is for starting and the closed button on the right is for stopping. The start button has normally open contacts which are closed when the button is pushed, and the stop button has normally closed contacts which are opened when it is pushed. After the start button is pushed to excite relay *B*, the closing of the two contacts at the top of relay *B* continues to excite relay *B* after the starting button is released and springs to its normally open position.

In starting knife switch No. 1 is first closed, which closes relay *A*. Knife switch No. 2 is closed, and then the start button is pushed. Immediately afterward alternating-current relay *B* closes, and this energizes the coil of the oil switch *C*, and the latter closes and connects the motor to its alternating-current lines. With the closing of the oil switch *C*, magnetic switch *D* is energized, which short-circuits the overload-relay windings. Simultaneously with the closing of *D*, governing relay *E* and time-limit relay *F* are also energized. Relay *E* will close when the inrush current to the motor has dropped to a certain predetermined value. If *E* does not operate, *F* will operate after a predetermined time, which may be varied at setting of an oil dashpot of the relay. The contacts of *E* or *F*, when closed, energize the coil of switch *G*. Now, when switch *G* closes, the field of the motor is connected to the direct-current lines. Simultaneously with the operation of *G*, relays *D*, *E* and *F* are all opened. The starter is now in its running position.

If the direct-current power lines are open or if the exciter set is not running, the starter cannot be operated for the reason that relay *A* will not close. Contacts of relay *A* are in series with the alternating-current circuit which operates the alternating-current relays and switches. Before the motor can be started, both alternating- and direct-current circuits must be alive and connected properly to the starter.

In case the governing relay should not operate, the time-limit relay *F* will operate after a predetermined time, which throws the direct-current excitation onto the motor. This feature actually limits the starting period of the motor.

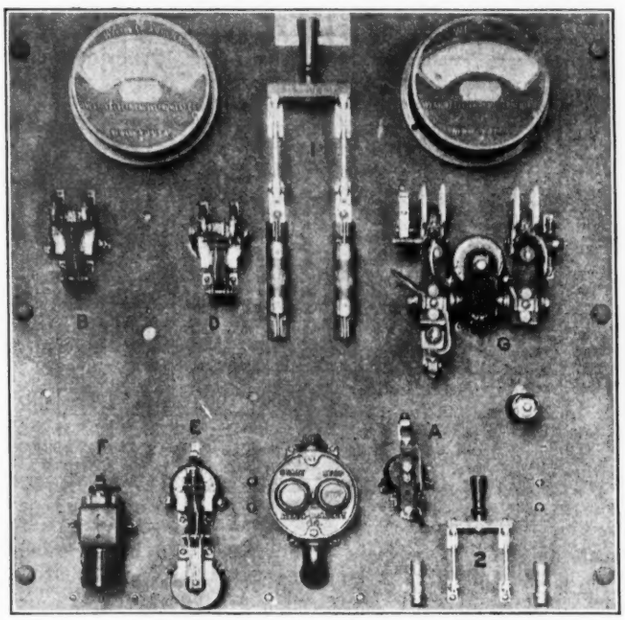


FIG. 4. FRONT VIEW OF FULL-AUTOMATIC STARTER FOR SYNCHRONOUS MOTORS
The automatic oil switch *C* shown on the diagram is mounted on the back of the panel.

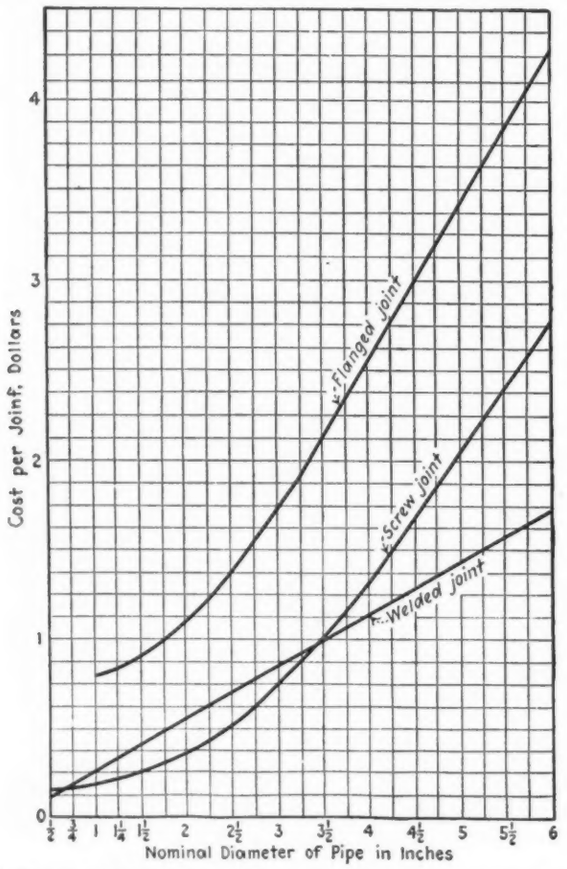
At the end of the starting period, switch *G* is closed. Now, if the motor is not in or near synchronism, the overload relays, which are now operative, will disconnect the motor and bring the whole starting mechanism to the off position.

The motor is given time-limit overload protection at a current setting, which can be adjusted very close to the full-load current rating of the motor. This has been accomplished, due to the short-circuiting of the overload-relay windings during the starting period. Not shown in the connection diagram is an auxiliary overload relay, which will open the oil switch in case the motor fails to start.

Relative Cost of Pipe Joints*

The accompanying curves show the cost of fitting pipes in railroad-shop power plants, both with flange fittings, screw fittings and welded joints, based on the cost per joint, which includes cutting two threads, fitting two flanges and bolts in the case of the flange fittings, or screwing and coupling in case of the screwed fittings.

It will be noticed that for sizes under 3½ in. the cost per joint in the case of welded pipe is a little more than the cost of screwed fittings until the smaller sizes are reached, where the two costs run about equal. For sizes 3½ in. and larger there is a material saving in cost, due to welded joints. In comparison with flanged fittings the saving is considerable for all sizes, averaging close to 50 per cent in the 1 to 6-in. sizes. However, the saving is not all in the first cost of the fittings, but by eliminating threaded joints



COST OF LABOR AND MATERIAL FAVORS WELDED JOINTS FOR LARGE PIPE

much longer life and less maintenance can be expected. This is especially true of long lines, such as air-distributing lines running through shops and car repair yards. The weakest point of a threaded pipe is at the threads, that is, so far as length of life is concerned. It is here that corrosion first takes place, which in a short time results in leakage of air or steam, or other contents of the pipe.

Two methods of welding pipe are suggested: One, a butt weld, in which the pipe is carefully faced on the end and in some cases scarfed; and second, a lap weld, made by using a sleeve, similar to a coupler without threads, slipped over the joint and the sleeve welded to the pipe at either end. Where the latter method is used, special fittings such as tees and ells could be made up economically on a production basis when the demand for such fittings became sufficiently large. When the butt weld is used, great care must be taken to prevent the formation of fins inside of the pipe that obstruct the flow. With the sleeve type of weld such obstructions are obviated and greater strength is given to the pipe at the point of the weld.

It is to be understood that no definite recommendations are made at this time for the welding of pipes. However, the possibility of saving by the use of welded instead of flanged or screwed joints is great. This applies to the smaller size pipes, 6 in. and under, where pressures are comparatively low, say not to exceed 150 lb. For power-plant work, where high-pressure headers are used, a different method of welding would have to be adopted.

*Excerpt from report of Committee on Modernization of Stationary Boiler Plants, Mechanical Division, American Railway Association, annual convention, June 14-17, Atlantic City.

Care and Operation of Worm Gears on Elevator Machines*

The worm gear drive on an elevator is one of the most important parts of the mechanism. Successful operation depends upon accurate alignment, large tooth surface contact, correct center distance and proper lubrication. A gear that receives no other attention than the necessary occasional addition of fresh oil may operate for years with very slight wear. The old oil, however, gradually accumulates a considerable quantity of metal particles that are held in suspension, and it also loses to some extent its lubricating qualities. It will usually pay therefore, to renew the oil once a year if the elevator is subjected to heavy service.

The best time to change the oil is during the early part of the summer, before the days become very warm. Proper lubrication is most difficult during the hot weather, when the oil becomes rather thin, and fresh oil should be used for this period. Worm gears seldom cut during the winter unless the elevator is operated at such a low temperature that the oil congeals. The oil should be drained from the worm-gear case after it has become well warmed by the continuous operation of the elevator.

The case should then be filled to the proper level with kerosene or paraffin oil and the elevator operated for several trips with a load on the car that is equal to about one-third of the capacity. This load must be placed on the car to balance the counterweight, which is heavier than the car. It is necessary to approximately balance the overweight to prevent the gear from cutting with this light oil. The top housing can then be raised and the inside washed.

The bolts that hold on the gear should be carefully examined to see that they are tight. If it is not convenient to remove the top housing the inside walls should be washed as clean as possible.

After the cleaning oil is drained from the worm-gear case the hand-hole plate should be removed and the inside of the case cleaned. Examine the worm and note the condition of the tooth surface. Note the amount of lost motion between the worm and the gear. Fill the worm-gear case to the proper level with a good grade of worm-gear lubricant.

The sediment in the old oil and in the cleaning oil should be examined for metal particles and dirt. The amount of heat generated by the worm-gear and thrust bearing is a good indication of their condition and also of the value of the lubricant. A suitable worm-gear lubricant should have several qualities not found in ordinary lubricating oil. The pressure at the point of contact between the worm and the gear is very high and the lubricant should have sufficient body to prevent metallic contact between the worm and the gear. The instantaneous temperature at the point of contact between the worm and the gear is as high as 350 deg. F., and it is necessary that the lubricant have a high flash point so that the life of the oil will not be quickly burned out.

Fortunately, the same qualities necessary for a good ball-bearing lubricant are found in a suitable worm-gear lubricant. While there is no sliding action in a ball bearing, the pressure at the point of contact is high and a high instantaneous temperature is generated. A suitable lubri-

*From instructions issued by the Warner Elevator Co.

cant must not have a great change in viscosity, due to the change in temperature ordinarily found in service.

Entire freedom from acid or alkali is absolutely necessary as either will cause pitting of the ball bearing. Vegetable oils should not be used because of their tendency to gum, neither should vegetable oil such as castor oil be mixed with petroleum base oils, for the same reason.

Graphite should not be mixed with the oil because of its tendency to pack the ball-bearing races. Graphite is not injurious to the worm-gear. Mild abrasives, such as sulphur or salt, should never be mixed with the worm-gear lubricant, because of the danger to the ball-thrust bearings. It is not possible to obtain a cheap lubricant that possesses the necessary qualities.

Oil Switch Accident Ties Up Brooklyn Rapid Transit System

On July 25 the short-circuit of a 66,000-volt, three-phase oil switch connecting a 10,000-kw. generator to the bus bars at the Kent Ave. station of the Brooklyn Rapid Transit Co. ignited the oil and resulted in a fire that might have been safely confined had construction work on the switch cells been advanced sufficiently. Under the circumstances a serious conflagration threatened. It was necessary to use water due to the insulation of overhead cables catching fire, coupled with the intense heat of the oil flames. This in turn necessitated a complete shutdown of the station which was supplying 100,000 kw. at that time, it being 5:15 p.m. with the subway load at its peak.

The trouble occurred on the fourth floor so that the water penetrated the floors below, requiring an extensive cleaning before the station could be placed in service again; hence the tieup of subway traffic for over an hour. The control room was not affected.

Two sections of bus were placed in operation shortly before 7 p.m., and approximately 55,000 kw. was then put on the feeders, the units having been kept turning over in order to be ready for the load on short notice. The auxiliary station of 20,000 kw. capacity supplied all the power possible, but this was not sufficient to be of material benefit.

Careful testing was necessary as the oil switches were placed in operation, and normal conditions were attained by 8:45 to 9 p.m., which included the placing of twenty-two sub-stations in operation.

The exact cause of the oil switch trouble has not been determined. Each of the three-phase tanks was grounded, and all were contained in one cell, the entire switch having been in operation only a short time. It is felt that completion of the construction work now under way will be ample protection against spread of fire in case of a future accident. No damage was sustained by the generator connected to the oil switch causing the trouble.

Why Stored Coal Overheats

Spontaneous heating in stored coal is governed principally by the size of the lumps, the initial temperature at the time of storage, the degree of ventilation within the coal pockets, and the length of the period of storage, according to a statement made by O. P. Hood, chief mechanical engineer of the U. S. Bureau of Mines.

The heating of coal is believed to be a surface phenomenon. If a ton of bituminous coal could be delivered in a single solid cube, each dimension of the cube would be about 2.8 ft.; the surface area of the cube would be about 47 sq.ft. If, now, the cube could be subdivided until all the pieces were fine enough just to pass through a 16-mesh screen, the area of exposed surface in one ton of coal would become an acre. This shows plainly why it is that trouble from spontaneous combustion originates in fine coal; the great increase in extent of surface does not begin until one gets below 1¼ in., or nut size. In a coal pile consisting of lumps greater than nut size the heating surface is relatively so small that spontaneous combustion seldom occurs.

A coal pile is cooled by radiation, and by the movement of air through it. Thus any air passing through a hot spot tends to carry away the heat with it. On the other hand, spontaneous heating is directly caused by contact of oxygen with the coal surface, therefore the passage of air through the coal pile is in itself a means of promoting local heating. This gives rise to a complicated problem in connection with the ventilation of coal piles, a problem that has not as yet been satisfactorily solved.

The freshness of the broken coal surface is another important factor. For the first few days after storage the freshly broken coal surface is very much more active in the taking up of oxygen, and consequent production of heat, than after a few weeks or months. Spontaneous fires rarely occur after the coal surfaces have been exposed for three months.

The initial temperature of the coal, at the time of storage, is still another factor. Coal put into storage at a temperature of 80 deg. F. will generate very much more heat per unit of surface than coal put into storage at the temperature of 60 deg. F. Thus coal storage during the hot months of summer, and in heated regions, is much more liable to spontaneous combustion than coal stored in colder climates and in cooler seasons of the year.

The questions of the sulphur or the volatile matter content of the coal, and the height of the pile, are minor considerations, according to Mr. Hood.

Was the Boiler "Ruptured" or "Cracked?"

By Arthur L. H. Street

Some difficulty was experienced by boiler doctors in diagnosing the condition of an impaired boiler in the case of Louisville College of Dentistry vs. Hartford Steam Boiler Inspection and Insurance Co., 215 Southwestern Reporter, 941.

Defendant issued to plaintiff a policy insuring against loss from explosion, collapse or rupture of the steam boilers in plaintiff's building. Alleging a rupture of one of the boilers, plaintiff sued on the policy. Holding that there was a right of recovery, the Kentucky Court of Appeals says on appeal:

The only fact in issue about which the court and the jury disagreed was whether the proven break or opening in a cast-iron part of the boiler, while under pressure of steam, was a "rupture" or a "crack." This issue was vital, because of a clause in the policy, and a rider attached to and made a part thereof, which, in so far as involved, are respectively as follows:

"(5a) By the term 'explosion' or 'rupture,' as used in this policy, is to be understood a sudden, substantial tearing asunder of the boiler, . . . or any portion thereof, caused by pressure of steam.

"It is hereby understood and agreed that the simple cracking of cast-iron parts of the boiler or boilers insured under this policy, whether under steam pressure or not, shall not be deemed an explosion, collapse, or rupture as insured against within the meaning of this policy."

The evidence, without contradiction, shows that while under pressure of steam, there suddenly appeared in a cast-iron part of the boiler what plaintiff insists was a "rupture," but which the defendant contends was merely a "crack." It was described by all of the witnesses as an irregular semicircular opening in a casting on the front of the boiler, about 15 inches long, and most of the witnesses testified that along the line of the cleavage and inside thereof the casting had bulged outward about one-half to three-quarters of an inch. One witness stated that the opening would admit a pencil; others that it was only the width of a knife blade.

We are quite unable upon this evidence to assert with confidence that this opening was either a rupture, as defined in the policy, or merely a crack, but clearly of the opinion that there was sufficient evidence it was a rupture, as defined in the policy, *i.e.*, "a tearing asunder of the boiler . . . or any portion thereof," not only to take the case to the jury, but also to sustain their verdict. This being true, the court erred in granting the new trial and setting aside the judgment in favor of plaintiff, and the same should be reinstated.

A complete topographic survey of the Green River, in Utah and Wyoming, is being made to determine power and reservoir site possibilities.

News in the Field of Power

Recognize Engineers' Service to Nation

In an attempt to win for the American engineer the recognition that has long been due him, the American Society of Mechanical Engineers is cooperating with the Smithsonian Institution in the establishment of a National Museum of Engineering, the first of its kind in the country, wherein shall be housed exhibits showing in vivid fashion the great progress made in engineering during the last eighty years.

The idea of a National Engineering Museum was the outgrowth of a recent collection of historical material connected with the fifty years' association of Cornelius H. De Lamater and Capt. John Ericsson, from 1840 to 1890, during which time their organization, known as the De Lamater Iron Works and located at the foot of West 13th Street, New York City, made memorable developments in naval, merchant-marine, ordnance and industrial engineering.

The secretary of the Smithsonian Institution has invited the committee of the A. S. M. E. in charge of this material to place it in the National museum of the Institution at Washington. He has expressed the hope that with this collection as a nucleus, there will gradually develop a great National Museum of Engineering, comparable with those of England, France and Germany, which shall serve as a record of the endless advance of engineering, and as a monument to the beneficent work of the engineer.

Conflicting Opinions on Federal Power Question

According to Col. Lewis Call, chief counsel of the Federal Power Commission, the holder of a preliminary permit for hydro-electric power construction is entitled to a license under the conditions set forth directly or indirectly in the preliminary permit. As the preliminary permit is issued in accordance with the provisions of the Federal Water Power Act and the regulations of the Commission issued thereunder, Colonel Call holds that these constitute a part of the permit, and that any conditions prescribed in the statute, or in the regulations, not specifically set forth in the preliminary permit, are nevertheless included by inference. He also holds that if the permittee complies with the conditions directly or indirectly expressed in his permit, and is willing to accept a license on the conditions set forth in the permit, he is legally entitled to the license.

The Judge Advocate General of the War Department, on the other hand, holds that even though a preliminary permittee has complied with all of the conditions of his permit, and is willing to accept the license upon the terms contained in the permit, the Commission may make its approval conditional upon acceptance of other or additional provisions, provided such conditions are for the purpose of obtaining the fullest development of the public resources under the terms of the Act.

These opinions were submitted in response to a request from the Federal Power Commission's executive secretary, O. C. Merrill. It is expected that a choice between them will be made at the next meeting of the commission.

Interstate Commerce Commission Issues Coal Priority Orders

Under the terms of the orders issued on July 25 by the Interstate Commerce Commission, the railroads are to move coal, coke, and fuel oil in preference to all other commodities save food for human consumption, feed for livestock, livestock and perishable products, and they are to move coal by the shortest routes, regardless of the desires of shippers or carriers.

Cars for coal loading are to be furnished first for fuel intended for railroads and for the bunkering of ships, and next for public utilities that directly serve the general public under a franchise. This includes street and interurban railways, electric power, light, gas, water and sewer works and ice plants.. Hospitals come next in the priority list. Other consumers then are listed in the following order: federal, state, county and municipal governments. The order points out that the intention is that all common carriers, public utilities, quasi-public utilities and governmental departments be kept supplied with coal for current use, "but not for storage, exchange or sale."

Priority is also given to coal for shipment to the Northwest by way of the Lakes and to the commercial sizes of coal for domestic use. The order provides that no coal is to be subject to reconsignment or diversion, except for some purpose in the same class or in a superior class. Mines producing coal are to be given first call on cars suitable for transportation of their output.

Connecticut Light and Power Co. Adds New Plant

A steam plant of 150,000 kva. ultimate capacity is to be constructed for the Connecticut Light and Power Co. as an addition to the company's existing steam and hydroelectric plants. By choosing a tidewater location, at Devon, Conn., near the mouth of the Housatonic River and also adjacent to the Naugatuck division of the New York, New Haven & Hartford Railroad, the company has provided for delivery of coal by both rail and barge.

Two 25,000-kva. units will form the initial equipment of the plant. The ultimate capacity has been set at 150,000 kva., but provision is being made for exceeding this figure, should occasion arise.

Citizens Finance Municipal Electric Plant

Recognizing the value of the municipal electric light service, a group of enterprising and public-spirited citizens of Frankfort, Ind., has recently offered to furnish the necessary capital for the purchase of certain much-needed equipment for the city's municipal electric power plant. Local conditions of more than ordinary interest have been responsible for this unusual situation.

The limit of the constitutional indebtedness of the municipality was recently reached, and accordingly the city found itself financially unable to complete the improvements necessary for the efficient operation of its power station. To meet the situation a fund of $75,000 was established under the direction of a trustee, who was authorized to purchase the necessary equipment. Under the terms of the "lease," as approved by the State Commission, the city is to pay $1,000 a month to the trustee of the fund until the cost of the expansion has been defrayed. The equipment will then become the property of the city.

This burden upon the plant over a period of years is negligible compared with the financial loss that would have occurred without the support of the group of local individuals, for the initial municipal investment would have been dissipated in a non-operative station with idle equipment. According to the citizens' plan, the plant will operate under equitable light and power rates, and will more than support itself.

Harding Praised for Handling of Coal Situation

Although the President has been criticized for calling the operators and miners together at the time he did, and for failing to outline definitely just what would be covered by the proposed arbitration, there is very general support for his conduct of the situation since the first conference deadlock. Some operators considered the conference ill-timed, in that the strike was about to begin to disintegrate when the Federal Government interfered. It is contended that encouragement was thereby given the striking miners. Other operators said that they were just on the point of producing coal when the conference was called. Nearly

all of them contended that protection was all that was needed to start up their mines. The President's action in sending the operators home to resume production has received commendation, for he thus gave them an opportunity to make good their claim that they could produce enough coal to meet the situation.

Price control, regulation of distribution, and rationing of the limited coal production now possible are some of the steps now receiving attention. Drastic action to curb profiteering, and to insure priority in the use of coal by the more essential activities, is more necessary now, it is contended, than at the time the Lever Act was passed. Certain senators recall that the Fuel Administration proved it to be impracticable to control prices without controlling distribution. Most senators are of the opinion that the effort in 1920 to control distribution without controlling prices was proven to be equally impracticable.

Women Run Substation

There is an electric substation in Atlanta operated solely by women, which, according to the Georgia Railway and Power Co., is the only one so operated in the country. The use of women in these positions was started during the war when men who could qualify were not available. At one time the company had nine women doing work of this kind but all of them have been replaced by men except three, who operate one station in eight hour shifts, and were retained for their capable and loyal service.

One of these young ladies showed that even a serious emergency could not find her unable to do her duty. On July 15 of last year a wire burned out on a commercial bus line and in an instant one end of the station was on fire. In spite of warnings and the fierce heat and smoke the young lady in charge remained at her post and threw the switches so that the fire was confined to the place of its origin.

Good Progress on Tugaloo River Hydro Plant

The Georgia Railway and Power Co. has in course of construction a dam and power plant which will develop 80,000 hp., an addition of 43 per cent to the company's hydro-electric output. The dam is being built across the Tugaloo River in North Georgia on the South Carolina boundary. This work was planned and authorized in 1917 but was halted by the war. It was reopened several months ago and is proceeding rapidly. The engineers state that the work is two weeks ahead of their schedule, and that they expect to complete it in about two years. At the present time there are 600 men employed on the job.

The dam is to be 142 feet high, 132 feet thick at the base, 850 feet across the top and it will contain 225,000 cubic yards of masonry.

New Publications

Mechanical Testing, Vol. 1—Testing of Materials of Construction. By R. G. Batson and J. H. Hyde (both of the National Physical Laboratory, Teddington, England). Published by E. P. Dutton & Co., 681 Fifth Ave., New York City. Cloth; 5½ x 8½ in.; 397 pages; 258 illustrations, including 69 photographs of testing machines. Price of Vol. 1, $9.

As part of the "Directly Useful Technical Series," this book fully lives up to the serial name and to the avowed purpose of steering a middle course between the so-called "theoretical" and "practical" books. Enough theory is given to enable the reader to understand the real meaning of the tests. The outstanding feature of the book is the completeness with which it covers the field of testing machines. Each type is clearly depicted by photographs and drawings, and its operation is described in detail. The following are some of the subjects treated: Load, strain, stress and elasticity; properties of materials; testing machines, testing-machine grips and shackles, and the calibration of testing machines; elongation and contraction of area in the tensile test; procedure in ordinary commercial testing; mechanical tests of hard-drawn wire; testing cast iron; influence of shape and time on the properties of materials; measuring instruments for the determination of the elastic constants of materials; autographic recording apparatus; determination of the elastic constant; experiments on the repetition of stresses; resistance of materials to combined stresses; rapid methods of determining fatigue ranges; alternating bending tests beyond the yield point; hardness and abrasion tests; impact and notched-bar testing; effect of temperature on the mechanical properties of materials; testing of timber; testing of stone, brick and concrete; testing road materials; limes and cements; list of British standard specifications and reports.

It is understood that the second volume, which will be uniform with Vol. 1, will be published shortly. Among other things this volume will deal with dynamometers, gears, lubricants, bearings, belting and brake lining, balancing, aircraft, etc.

Forms, Records and Reports in Personnel Administration. Edited by C. N. Hitchcock. Published by the University of Chicago Press, Chicago, Ill. Paper; 128 pages. Price, $1.79 postpaid.

A collection of typical forms, records and reports, assembled for the use of personnel managers, showing what data the management of a business should have on hand and illustrating the daily routine of the personnel department.

Working of Dynamos and Electric Motors. Published by The National Boiler and General Insurance Co., Ltd., National Buildings, St. Mary's Parsonage, Manchester, England. Paper; 5½ x 8 in.; 45 pages. Price 1s. 6d.

Operation and maintenance of engine-driven generators, together with small motors, with a view to preventing accidents is described briefly and satisfactorily. Important points are well illustrated, and the advice is evidently the result of hard-won experience, making the volume a good investment for the progressive engineer or operator.

Steam Turbines. By William J. Goudie, D. Sc., member of the Institution of Mechanical Engineers; member of the Institution of Engineers and Shipbuilders in Scotland; assoc. member of the Institution of Civil Engineers; and James Watt, professor of "The Theory and Practice of Heat Engines" in the University of Glasgow. Cloth; 6 x 8½ in.; 800 pages, 329 illustrations. Price, $10. Second edition rewritten and enlarged, 1922. Longmans Green and Co., 55 Fifth Avenue, New York City, and 39 Paternoster Row, London, E. C.

The present edition represents present developments in the art of turbine design, which has made great strides since 1917. Many illustrations and diagrams show actual commercial turbines, and the author has taken great pains to inform the student of the many design coefficients derived from manufacturing experience, and to present a basis of practical design, rather than abstract theory. Classification of steam turbines is first dealt with, illustrated principally by European machines. Design is then taken up, including properties of steam, nozzles, blading, rotors, stators, gears, steam consumption and

Coming Conventions

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Des Moines, Ia., Sept. 11-16. Annual conventions and exhibitions of the State Associations scheduled as follows:

Minnesota, at Minneapolis, Aug. 9-11; C. A. Nelsen, 800 22nd Ave., N. E., Minneapolis.

Iowa, at Des Moines, Sept. 10-11; Abner Davis, Room 16, Waterhouse Block, Cedar Rapids, Iowa.

Universal Craftsmen Council of Engineers; Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Annual convention and exhibition at Cleveland, Aug. 7-11.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Pacific Coast Convention at Vancouver, B. C., Aug. 8-11.

National Safety Council, 168 N. Michigan Ave., Chicago, Ill. Eleventh Annual Safety Congress, Detroit, Aug. 28-Sept. 1.

International Union of Steam and Operating Engineers. Dave Evans, 6334 Yale Ave., Chicago, Ill. Biennial convention and exhibition at Minneapolis, Minn., Sept. 11.

Association of Iron and Steel Electrical Engineers, 1007 Empire Bldg., Pittsburgh, Pa. Annual convention and exhibition at Cleveland, Ohio, Sept. 11-16.

economy, and proportioning compound turbines. Intricate theory is illustrated in its application to commercial types of machines and, later on, numerous examples serve to fix the application of such theory. The use of standard sizes for stators or other elements is not assigned the importance in design which would ordinarily apply in manufacturing work, but this appears to incline toward methods of education recently advocated, of leaving the finishing and specialization of engineering training to be completed in the actual business of manufacturing. Besides convenient charts and tables, there is much data that would be useful to designing engineers.

Mexican Petroleum. Published by the Pan-American Petroleum and Transport Co., New York City.

A 292-page book describing the company's Mexican oil holdings. The editor has gone beyond the bare recital of the development of the company's property and describes in a most interesting way the early discoveries of oil springs in Mexico, the drilling and bringing in of the gushers whose productions have made Mexico the third largest producer of petroleum. In addition, there are brief descriptions, illustrated by many photographs, of all the well known oil fields in the world. While the primary motive of this volume was to obtain publicity for the Pan-American company, so well has the editor performed his work that a most interesting and valuable treatise on petroleum has resulted.

Hydraulics With Working Tables. By E. S. Bellasis, M. Inst. C. E., recently superintending engineer in the irrigation branch of the Public Works Department of India. Author of "River and Canal Engineering," "Irrigation Work," etc. Published by E. P. Dutton and Co., 681 Fifth Avenue, New York City, 1922. Cloth; 6 x 8½ in.; 348 pp. Price, $8.

As indicated by the title page, this publication is based on personal experience of the author. The following is quoted from the introduction: "The chief object is to deal thoroughly with the facts, laws, and principles of Hydraulics, and to keep always in view their practical aspects.

"The enormous waste caused by the use of erroneous co-efficients is known to all. Another important object is to remedy this. The use of old and inaccurate figures—as some recent papers show—is not uncommon. Fresh discussion on all the most important co-efficients is now given and specific recommendations are made. A new set of co-efficients for pipes is given.

"Numerous examples of practical problems are included, and full sets of tables for working them out."

Its ten chapters treat of water flow through orifices, short tubes, weirs, pipes, and open channels, with uniform and variable flow. Hydraulic observations, methods and instruments, together with a chapter on dynamic effect of flowing water, and a well grouped index complete the book.

Obsolete matter and long mathematical investigations are avoided. The book is intended to meet the requirements of both the student and the engineer.

Power Alcohol. By G. W. Monier-Williams. Published by Henry Frowde and Hodds and Stoughton, London and Oxford University Press, New York City. 312 pages; 48 illustrations. Size 6 x 9; cloth binding. Price $7.

The volume covers the problem of the production and utilization of alcohol. The author takes up practically all the raw materials from which alcohol could be made and shows not only the process required but also the cost per gallon of alcohol. A perusal of this treatise convinces one that alcohol can never replace petroleum products as a source of power as long as a supply of the latter is available. It is pointed out that the manufacturing costs will average 10 to 12 cents per gallon, this being much higher than the average production cost of petroleum products.

Obituary

Edward E. Odell, a noted consulting engineer of Boston, died recently of heart trouble at the age of 81. Mr. Odell was identified with many of the largest building projects in New England. During the last thirty years he has been in charge of Reed's Block, a Boston manufacturing plant. He was a native of Salem, Mass., and a member of the N. A. S. E. and other engineering societies.

Personals

Gerard Swope, president of the General Electric Company, has been elected a Fellow of the American Institute of Electrical Engineers.

H. Wright of Montreal has been appointed President of the Canadian Association of Stationary Engineers, at the association's annual convention held at Kitchener, Ontario.

Col. Arthur S. Dwight, president of the American Institute of Mining and Metallurgical Engineers, and Charles S. Rand, chairman of Engineering Foundation, were recently decorated by the French Government with the Chevalier Cross of the Legion of Honor.

Business Items

The Johns-Pratt Co., of Hartford, Conn., has established a New York office in the Liggett Bldg., 41 East 42d Street. The new office will handle the company's products: Noark fuses and protective devices, Vulcabeston packing and Johns-Pratt molded products.

The Conveyors Corporation of America, 326 West Madison St., Chicago, has appointed the Mid-West Engineering Sales Co., Masonic Temple, Cedar Rapids, Iowa, as its representative in eastern Iowa for the sale of "American Trolley Carriers," coal handling equipment of the monorail type.

Trade Catalogs

Ash Discharge—American Engineering Co., Philadelphia, Pa. A 20-page catalog describing the company's "Rotary Ash Discharge."

Rust, its Cause and Prevention—Oil Specialties Supply Co., 39 Cortlandt St., New York City. An eight-page booklet explaining in a general way the problems and methods of rust prevention.

Radiator Valves—The Ohio Brass Co., Mansfield, Ohio. Price list, description, and operating instructions for the various types of "O-B Packless Graduated Steam Radiator Valves." A 10-page booklet.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	July 17, 1922	July 24, 1922
Pool 1,	New York	.....	.....
Smokeless,	Columbus	$3.50–4.00	$5.50–6.50
Clearfield,	Boston	3.00–3.75	3.50–3.75
Somerset,	Boston	3.25–3.75	3.50–4.00
Kanawha,	Columbus	3.50–3.85	5.25–6.25
Hocking,	Columbus	3.60–3.80	5.00–6.00
Pittsburgh No. 8	Cleveland	4.25–4.50	7.00–7.50
Franklin, Ill.,	Chicago	.....	.....
Central, Ill.,	Chicago	.....	.....
Ind. 4th Vein,	Chicago	.....	.....
West Ky.,	Louisville	6.00–6.25	10–10.50
Big Seam,	Birmingham	2.00–2.40	2.20–2.50
S. E. Ky.,	Louisville	4.00–4.25	9.00–9.50

FUEL OIL

New York—July 27, Port Arthur light oil 22@25 deg. Baumé 4c. per gal.; 30@35 deg., 5c. per gal. f.o.b. Bayonne, N. J.

Chicago—June 28, for 24@26 deg. Baumé, $1.15 per bbl.; 21@36 deg., 3¼c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—July 25, f.o.b. refinery, Pennsylvania, 36@40 deg., 5c.; Kentucky fuel oil, 24@30 deg., 4c. per gal.; Gas oil, 32@34 deg., 3¼c. per gal.; 36@38 deg., 3½c.; 38@40 deg., 3¾c. Western, 24@30 deg., $1.35 per bbl.

Philadelphia—July 24, 26@28 deg. Baumé, Oklahoma, 80c.@90c. per bbl.; 30@34 deg., Oklahoma (group 3), 2⅝c.@2⅞c. per gal.; 16@20 deg. Seaboard, $1.35@$1.50 per bbl.

Cincinnati—July 13, for 26@30 deg. Baumé, 5c.; Diesel, 32@34 deg., 5¼c. per gal.; distillate 38@46 deg., 5⅝c.

Cleveland—July 13, 26@30 deg. Baumé, 4c. per gal.

New Plant Construction

PROPOSED WORK

Ala., Birmingham—The Benoit Coal Mining Co., C. S. Bissell, Pres., 1908 Jefferson City Bank Bldg., plans to electrify the mine and is in the market for 10 d.c. motors.

Ariz., Yuma—The U. S. Reclamation Service, Denver, Col., will receive bids until Sept. 6 for furnishing motors, transformers and switching apparatus for the Valley Drainage Pumping Plant, here.

Cal., Fresno—The San Joaquin Light & Power Co., 1801 Tulare St., have had plans prepared for a 48 x 110 ft. addition to substation on Orange Ave. to increase capacity from 10,000 to 17,000 hp. Estimated cost $102,000.

Cal., Long Beach — The Cooper Arms Bldg. Co., c/o W. G. Blatt, Security Trust & Savings Bank, is having preliminary plans prepared for a 12 story, 100 x 202 ft. apartment building on Ocean Blvd. Estimated cost $1,400,000. Fitzhugh & Teal, 401 West Ave. So., Los Angeles, Archts.

Cal., Los Angeles—The Bd. Public Service Comn., 210 South Broadway, is having plans prepared for 7 substations and the extension of city light and power lines. Bids will be received for equipment. Estimated cost $6,000,000. E. F. Scattergood, Engr.

Cal., Mare Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until Aug. 30 for circulating loop for central power plant here, consisting of two 48 in. intake conduits, 60 in. discharge conduit, intake and discharge structures, shafts, sluice gates, operating machines, etc. Spec. 4634. Noted July 25.

Cal., Sacramento—The city, H. G. Denton, Clk., will receive bids until Aug. 24, for rapid sand filtration plant and appurtenances comprising complete construction of sedimentation and coagulation basins having an aggregate capacity of approximately 10,500,000 gal., 8 rapid sand filters, nominal capacity 32 million gal. per day, a superstructure over the operating gallery of the filters, a head house for administration purposes in which there is a 200,000 gal. elevated water tank for filter washing purposes, a sump having approximately 200,000 gal. capacity, coagulant building and outside piping, etc., also mechanical equipment, including pipe and fittings, gate valves, sluice gates, hydraulic and electrical controlling devices, gauges, conveyors, pulverizers, etc.

Cal., Sacramento—The State Dept. Pub. Wks., Div. of Architecture, will receive bids until Aug. 29 for heating, ventilating and plumbing systems and electrical work for library, court and office buildings of the State Capitol Extension Group. Estimated cost $150,000. Weeks & Day, Phelan Bldg., San Francisco, Engrs.

Cal., San Pedro—J. D. Finley plans to build a 4 story, 100 x 130 ft. hotel including steam heating system, on 6th and Mesa Sts. Estimated cost $200,000. W. F. Bowen, 813 Union League Bldg., Los Angeles, Archt. Work to be done by day labor.

Cal., Santa Barbara—The High School Bd. of Trustees, Anapamu and De la Vina Sts., plans to build a high school including steam heating system on Corrillo St. Estimated cost $450,000. Weeks, Sauter & Lockard, San Marcos Bldg., Archts. Noted Mar. 21.

Ill., Altamont — The city, H. E. Will, Comn. Public Property, will receive bids until Aug. 7 for waterworks improvements consisting of storage reservoir, pump pit and sump, 1 mi. 6 in. low head pipe line, 1 mi. 2200 volt 3 phase transmission line, 2 motor driven centrifugal pumps and connections. Fuller & Beard, Railway Exchange Bldg., St. Louis, Mo., Engrs.

Ill., Chicago—J. P. Cowing Engineering Co., Archts., 30 North LaSalle St., is receiving bids for 2 story 100 x 250 ft. stores and office building including steam heating system, on Randolph St., for C. A. Stanton, South Bend, Ind. Estimated cost $250,000.

Ill., Chicago—W. F. Hall Co., Chicago and Kingsbury Sts., plans to build a printing plant including steam heating system, on Kilpatrick between Diverse and Wellington Sts. Estimated cost $8,000,000. Architect not announced.

Ill., Chicago—Henschien & McLaren, 1637 Prairie Ave., will soon receive bids for a 4 story 75 x 150 ft. packing plant near Union stock yards, for the Western Packing & Provision Co., 3854 South Morgan St. Estimated cost $170,000.

Ill., Jacksonville—The city plans extensions and improvements to municipal electric power plant here. Caldwell Engineering Co., Engrs.

Kan., Satanta—The city plans election Aug. 7 to vote $30,000 for pumping and distribution systems. Estimated cost $40,000. Ruckel Engineering Co., Interurban Bldg., Hutchinson, Engrs.

Ky., Summit—The Pittsburgh Brick & Tile Co., c/o S. S. Willis, Ashland, plans to build a brick manufacturing plant, on 400 acre site, here. Estimated cost $200,000. Architect not announced.

La., Plaquemine—The Bd. of Aldermen and F. Wilbert, Mayor, will receive bids until Sept. 15 for remodeling the electric light and water works plant. Estimated cost $150,000. Swanson-McGraw Inc., 705 United Fruit Bldg., New Orleans, Consult. Engrs. Noted May 16.

Md., Baltimore—S. T. Williams, 223 North Calvert St., is in the market for cable way hoisting engine with winding and endless rope drum for electric drive, with or without motor, 35 to 40 hp., and electrically driven air compressor suitable for about 3 jack drills, with or without motor, both 3 phase, 60 cycle, 220 volts, a.c.

Mass., Holyoke—Farr Alpaca Co., Jackson St., had plans prepared for a 6 story 100 x 500 ft. yarn mill. Estimated cost $1,000,000. S. M. Greene & Co., 293 Bridge St., Springfield, Engrs. and Archts.

Mich., Benton Harbor—The city, G. Tyler, Mgr., will receive bids until Aug. 10, for piping and equipment for water softening and purification plant, 2 million gal. per day capacity, also a 2 story superstructure.

Mich., Detroit—The city, E. J. Bestick, Clk., will soon award the contract for power plant equipment, including steam driven generating unit 300 kva. capacity, 250 hp. water tube boiler with stokers. Estimated cost $32,000. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, Engr.

Mich., Detroit — L. Kamper, Archt., Kamper Bldg., 3729 Cass Ave., will receive bids until Aug. 5 for 21 story 60 x 100 ft. office building including steam heating system, on Washington Blvd., for J. B. Book, Book Bldg.

Mich., Hamtramck (Detroit P. O.)—The city, J. J. Mitchell, Clk., is in the market for portable air compressor complete with hose and couplings, 225 lbs. free air per min., 4 cylinder 40 hp. gasoline motor, 20 gal. fuel tank and air receiver, 12 cu.ft. capacity.

Mich., Lincoln Park (Wyandotte P. O.)—The village has had plans prepared for sewer and sewage pumping station, pumping equipment consists of 3 units, motor driven horizontal centrifugal pumps, 1 unit 500 gal., one 1,500 gal. and one 3,000 gal. per min. capacity. R. A. Murdoch, 603 Free Press Bldg., Detroit, Engr.

Mich., Mt. Clemens—The Bd. Educ. plans to build 2 story 140 x 260 ft. high school, including steam heating system and mechanical ventilators, on Cass Ave. Estimated cost $650,000. J. C. Llewellyn Co., 38 South Dearborn St., Chicago, Ill., Archts.

Mich., River Rouge—The Ford Motor Co., Highland Park, plans to build a 60 x 300 ft. addition to tractor and automobile factory, here, including steam heating system with piping and general equipment. A. Kahn, 1000 Marquette Bldg., Detroit, Archt.

Mich., Saginaw—The Bd. Educ., Manual Training Bldg., East Side, will receive bids until Aug. 8 for 2 story school, and first unit of power house, including boiler and equipment, also mechanical ventilating equipment, on Webber St. Estimated cost $250,000. J. F. Beckbissinger, 114 South Jefferson Ave., Archt. Noted July 11. Date of bids changed from July 12.

Minn., Glen Lake (Hopkins P. O.)—The Hennepin Company Sanatorium Corms, A. P. Erickson, Auditor, received bids for the heating, plumbing, ventilating and sewage systems for group of buildings at Sanatorium here, from Tibbetts & Wise, Wayzata, $125,000, H. Kelly & Co., 925 Plymouth Bldg., Minneapolis, $145,000, Archambo Heating & Plumbing Co., 315 South 5th St., Minneapolis, $149,950.

Minn., Mankato—The State Bd. of Control, D. F. Mullen, Secy., The Capital, St. Paul, will receive bids until Aug. 8 for 3 story administration school, including steam heating system, for the State Teachers College. Estimated cost $250,000. C. H. Johnston, 715 Capital Bank Bldg., St. Paul, Archt. C. L. Pillsbury Co., 1200 Second Ave. South, Minneapolis, Engrs.

Minn., Minneapolis—The S. T. McKnight Co., 1236 McKnight Bldg., is having plans prepared for 6 story 92½ x 158 ft. store and office building including steam heating system on 1st Ave. N. and 7th St. Estimated cost $325,000. Hewitt & Brown, 1200 2nd Ave. S., Minneapolis, Engrs.

Minn., Winona—The city is having plans prepared for waterworks pumping station. Estimated cost $250,000. Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Ill., Engrs.

Mo., Joplin—L. M. Hitchcock, 201 Haas Bldg., is in the market for a 150 hp. gasoline or oil engine.

Neb., Emerald—The Emerald Motor Co., M. Luhlutz, Purch. Agt., is in the market for a 150 lb. compressor for service station.

N. Y., Buffalo—The Buffalo Club, H. P. Werner, House Comnr., 388 Delaware Ave., plans the construction of a power house and heating plant, in connection with the club house. Estimated cost $30,000. Is in the market for boilers and equipment.

N. Y., Lackawanna—Hoepfinger Bros., plan to build 7 story hotel on Ridge Road. Estimated cost $450,000. Architect not announced.

N. Y., Lockport—The Niagara County Bd. of Supervisors, F. H. Krull, Clk., is in the market for two 40 hp. boilers.

N. Y., New York—The Dept. of Plant and Structures, G. A. Whalen, Comr., Municipal Bldg., will receive bids until Aug. 3 for steam heating and ventilating apparatus for proposed housing station for the Dept. of Street Cleaning at 132 St. west of Willow Ave., Borough of Bronx.

N. Y., Rochester—M. Ertel, 27 Arthur St., is in the market for a medium size, portable or locomotive type boiler.

N. C., Asheville—J. E. Swain, representing owner, has purchased site and plans to build 6 story apartment hotel on Haywood St. and Cumberland Ave. Estimated cost $250,000. Architect not announced.

N. C., Kinston—The Caswell Training School, Bd. Trustees, Dr. C. B. McNairy, Supt., plans the construction of an administration building to cost $400,000 and ultimately other buildings to cost $890,000.

N. C., Hobgood—The Bd. of Town Comrs. and Mayor, will receive bids until Aug. 15 for furnishing materials for building 7 mi 3 phase 11,000 volt transmission line to Scotland Neck. Also equipment for the distribution of electricity in Hobgood.

N. D., Walhalla—The city auditor will receive bids until Aug. 26 for waterworks and distribution systems, including pumping station well, elevated tank or reservoir, also piping. Estimated cost $20,000. C. L. Pillsbury Co., 1200 2nd Ave., South, Minneapolis, Engrs.

Ohio, Columbus—The American Gas & Electric Co., R. L. Buffington, Mgr., has purchased two sites on the Muskingum River and optioned one site on the Ohio River which are intended as possible locations for power plants, one of the sites on the Muskingum River is located at Duncan Falls, Philo, the other site at Mariam Station 15 mi. south of Zanesville. A 60 year power and light franchise has been secured from the village council of Philo.

Ohio, Geneva—The city received bids for building pumping station, including filter beds and furnishing and erecting Imhoff tank from the Ashtabula Construction Co., Ashtabula, $49,500, Johnson-Erickson Construction Co., Ashtabula, $57,000.

Ohio, Logan—The Ohio Power Co. plans the construction of 30 mi. of high tension transmission lines to Lancaster also from here to Nelsonville.

Ohio, Sandusky—The Chamber of Commerce, Masonic Temple and the Ajax Rubber Co. of New York plan to build a rubber manufacturing plant here. Estimated cost $1,000,000. Engineer not announced.

Pa., Bethlehem—The Confederated Home Abbatoirs Co., Portland, Me., plans to secure site and build an abbatoirs products plant here. Estimated cost $1,000,000. Architect not selected. Quotations wanted on machinery and equipment.

Pa., Monongahela—The school district plans to build 2 story high school. Estimated cost $250,000. W. G. Eckles, New Castle, Archt.

Pa., Pittston—The Howell & King Co., P. F. Joyce, Pres., Crown and Thomas Sts., is in the market for machinery and equipment for proposed artificial ice plant.

Pa., Saxton—Penn Central Light & Power Co. plans to build a 2 story power house, capacity 40,000 kw., and a 600 ft. dam. Day & Zimmerman, Inc., 611 Chestnut St., Phila., Engrs.

Pa., Union City—The city plans to install 85 hp. engine to operate pumps and lay 1,400 ft. 14 in. cast iron pipe to replace wooden pipe system at wells. Engineer not announced.

Pa., Vandergrift—The West Penn Power Co. Hartje Bldg., Pittsburgh, plans to rebuild substation, here, destroyed by fire. Estimated cost $20,000.

Pa., Williamsport—A. B. Faulkner, 720 Fifth Ave., is in the market for electric motor, 110 volts. (Medium size).

Pa., York—C. Welsh has had plans prepared for remodeling Hotel Pennsylvania on George St., consisting of 6 story 96 x 130 ft. addition. Estimated cost $300,000. Toohey & McClymont, 342 Madison Ave., New York, Archts.

Tex., Ft. Worth—The city council will soon receive bids for large disposal plant, including sprinkling filter system, 3 filter beds, 4 Imhoff tanks, and three 16 in. centrifugal pumps. Estimated cost $500,000. F. E. Sands, Mason Bldg., Houston, Consult. Engr.

Wash., Tacoma—The Carstens Packing Co., Tide Flats, plans to build a 4 story 67 x 72 ft. meat packing plant with 32 x 40 ft. wing. Estimated cost $1,300,000. P. V. Cornils, c/o owner, Archt.

W. Va., Charleston—The Kanawha Investment Co. plans to build an 8 story 161 x 168 ft. office building on Summers and State Sts. Architect not selected.

Wis., Iron Ridge—The City, J. Schwartz, Clk., will receive bids until Aug. 7, for 7,500 ft. 4-12 in. water pipe, hydrants, valves, 40,000 gal. tank on 55 ft. tower, complete foundation and erection, 100 g.p.m. pump and motor for 6 in. well. J. Donohue Co., 606 North 8th St., Engr.

Wis., Madison—Mead & Seaston, Engrs., State Journal Bldg., are receiving bids on ash handling equipment for the power house of the Madison Gas & Electric Co., 120 East Main St.

Wis., North Milwaukee—The Joint School District No. 17, c/o W. H. Greiner, 398 34th St., plans to build a 2 story high school. Estimated cost $200,000 to $300,000. Architect not selected.

Wis., Oshkosh—The Kuebler Grocery Co., Auler & Jensen, Archts., 282 Main St., are receiving bids for an ice machine and refrigerating apparatus.

B. C., Enderby—The town plans to build an electric light plant. Estimated cost $25,000. Prices wanted on equipment.

Ont., Aurora—The Taylor Rubber Co., 37 Richmond St., East Toronto, have purchased a 45 acre site on Yonge St. and plan to build an automobile tire factory. Estimated cost $300,000. Architect not announced.

Ont., Fort William—The Fort William Paper Mills plan to build a mill on Mission St. Estimated cost $300,000. Private plans. Prices wanted on machinery and equipment.

Ont., Leaside—The Durant Motors of Canada, 909 Royal Bank Bldg., Toronto, is receiving bids for automobile factory consisting of 5 buildings, including steam heating and blower systems. Estimated cost $500,000. Private plans.

Ont., London—St. Peters Parish, Bishop Fallon, Bishop's House, plans to build a central heating plant for heating Cathedral, Parish Hall, school and palace. Estimated cost $28,000.

Ont., Niagara Falls—The city council plans to install ornamental lighting, including 69 standards and pumps, on Erie and Victoria Aves. and Queen, Centre and Culp Sts. Estimated cost $24,125. Engineer not announced.

Ont., Owen Sound — Watt & Blackwell, Archts., Bank of Toronto Bldg., London, will receive bids until Aug. 16 for school building, here, including steam heating and ventilating systems. Noted May 30.

Ont., Petrolia—The Peninsular Sugar Co., F. H. Hubbard, Genl. Mgr., will soon receive bids for 1 and 2 story 250 x 800 ft. main building and 1 story 175 x 225 ft. power house in connection with sugar refinery. Estimated cost $1,500,000. Honolulu Iron Works, 8047 Hamilton Blvd., Detroit, Mich., Engrs. Prices wanted on boilers and power house equipment. Noted July 18.

Ont., Toronto—A. D. LePan, Engr., University of Toronto, will receive bids until Aug. 26 for a turbo-generator set, for the University of Toronto.

Alta., Hanna—The City, C. N. Tingle, will receive bids until Aug. 7 for electric lighting equipment, including the installation of 100 K.W. generator and exciter direct connected to compound steam engine, 150 kw. unit similar to above, 2 150 hp. return tubular or water tube boilers and accessories, including mechanical stokers, switchboard and street lighting equipment, transformers, and copper wire.

Australia, Victoria, Melbourne — The State Electricity Comn., R. Liddelow, Secy., will receive bids until Sept. 16 for Spec. No. 261 strain and pin type insulators for the Morwell Power Scheme.

CONTRACTS AWARDED

Cal., Oakland—The Star Motor Co. of Cal., c/o Durant Motor Co., East 14th St., has awarded the contract for 80 x 150 ft. administration building and 100 x 200 ft. warehouse for automobile plant, to the P. J. Walker Co., Monadnock Bldg., San Francisco. Total cost, $1,000,000.

Ill., Chicago—Lowe & Bollenbacker, Archts., 108 South LaSalle St., has awarded the contract for 5 and 6 story, 125 x 125 ft. Y. M. C. A. building on 53 and Dorchester Sts., to C. B. Johnson & Son, 111 West Washington St. Estimated cost $400,000. Owner's name withheld. Steam heating system will be installed. Noted May 16.

Ill., Chicago—The Allerton House Co., 143 East 37th St., New York, c/o S. G. Shepard, 112 West Adam St., Chicago, has awarded the contract for 20 story, 109 x 150 ft. hotel on Michigan Ave. and Huron Sts., to the McLennan Construction Co., 400 North Michigan Blvd. Estimated cost $3,000,000. Steam heating system will be installed. Noted June 20.

Ill., Chicago—The Commonwealth Edison Co., Clark and Adams Sts., has awarded the contract for 6 story, 120 x 280 ft. addition to power plant, on 100th St. and Ave. N., to Geo. A. Fuller & Co., 140 South Dearborn St. Estimated cost $1,000,000.

Ind., Lafayette—The Student Union Bldg. Co., Dr. T. F. Moran, Chn., has awarded the contract for 2 story, 300 x 650 ft. Student Union building near Purdue University to A. E. Kimmer, 644 North 7th St. Estimated cost $1,500,000. Noted Apr. 11.

Ind., Marion—The Bd. Educ. has awarded the contract for 2 story, 170 x 217 ft. Junior high school on 36 and Washington Sts. to Morrow & Morrow, Muncie, $239,500. Noted July 25.

Ia., Ft. Madison—The Bd. Educ., J. Low, Jr., Secy., has awarded the contract for 3 story, 150 x 178 ft. high school to J. W. Hopp Co., 415 Granby Bldg., Cedar Rapids, $215,000. Steam heating system will be installed. Noted June 27.

Ia., Maquoketa—The Bd. Educ., C. W. Farr, Secy., has awarded the contract for a 2 story high school, including steam heating system, to the Currie-Simpson Co., Waterloo, $162,480. Noted June 20.

La., New Orleans—The Sewerage & Water Bd., A. G. Moffat, Secy., has awarded the contract for a 6,000 hp. turbine engine and accessories to the Westinghouse Electric Manufacturing Co., Maison Blanche Bldg., $117,000. Noted June 20.

Mich., Detroit—The Dept. Motor Transportation, City Hall, has awarded the contract for furnishing and installing heating system, including boilers, piping, valves, pump and accessories, in municipal garage, to the Grinnell Co., Inc., 710 Ford Bldg., $33,757.

Mich., Sault Ste. Marie—The U. S. Government, Engineering Dept., 337 Federal Bldg., Detroit, has awarded the contract for 6 operating engines, including motors, controllers, resistances, electric winding drums, etc., for gates for Poe Locks, to the Green Bay Dry Dock Co., Green Bay, Wis. $20,410. Noted July 25.

Minn., Duluth—The McDougall Terminal Warehouse Co., 510 Alworth Bldg., A. M. McDougall, Pres., has awarded the contract for a refrigeration plant and terminal warehouse on 9th Ave. and Railroad St., to Jacobson Bros., 406 Columbia Bldg., $1,000,000. Artificial ice plant and refrigeration equipment will be installed.

N. Y., Buffalo—The Hens & Kelly Co., 478 Main St., has awarded the contract for department store on Main St. to C. Berrick & Sons, 1151 Main St., about $700,000.

Ohio, Bellaire—The National Bank has awarded the contract for 8 story 40 x 120 ft. bank building on 32 and Belmont Sts., to the C. D. Keyser & Co. Estimated cost, $400,000. Noted July 4.

Ohio, Dayton — The Bd. Educ., C. A. Schmidt, Clk., has awarded the contract for a 3 story Roosevelt high school including steam heating system and plumbing, to the Walbridge-Adlinger Co., 2356 Penobscot Bldg., Detroit, Mich., $1,434,210. Noted July 25.

Ohio, Dayton — The Dayton Light & Power Co., Jefferson St., has awarded the contract for 5 story, 85 x 180 ft. electric power plant on Millers Ford to Thos. E. Murray, Inc., 55 Duane St., New York, $300,000.

Ohio, Zanesville—The Zane Hotel Co., W. M. Bateman, Pres., has awarded the contract for a 6 story hotel to the Blanchard Bldg. Co., 928 Lindsay Bldg., Dayton, $350,000.

Pa., Dallas—The Sisters of Mercy, 161 South Washington St., Wilkesbarre, have awarded the contract for 3 and 4 story, 50 x 152 ft. and 43 x 59 ft. mother house and power house here, to the F. V. Warren Co., 132 South 17th St., Phila.

Pa., Moosic—The Spring Brook Water Supply Co., has awarded the contract for the construction of a dam 1,490 ft. long, 125 ft. high, capacity 1,800,000,000 gal., about 9 mi. from here, including 900 ft. tunnel, to Winston & Co., American Natl. Bank, Richmond, Va., about $1,000,000.

Pa., Phila.—The Reformed Church of America, 15th & Race Sts., has awarded the contract for 13 story, 120 x 120 ft. office building to the Cramp & Co., Denckla Bldg., $650,000. Noted July 11.

Wash., Seattle—The Dexter-Horton Estate, New York Blk., has awarded the contract for 12 story bank and office building to the Puget Sound Bridge & Dredging Co., Central Bldg., $2,500,000. This structure will replace 3rd Ave. half of present New York Block and similar structure will replace Cherry St. half of building. Noted July 11.

Wis., Milwaukee—The Nash Motors Co., Clement Ave., has awarded the contract for 1 and 2 story manufacturing and office building to Theo. Stark & Co., 130 Muskego Ave. Estimated cost $300,000. Steam heating system will be installed. Noted May 10, 1921.

Ont., Oakville—The City has awarded the contract for 1,000 g.p.m. auxiliary gasoline driven fire pump to Goldie McCulloch Co. $32,000.

Ont., Toronto—The Bd. Educ., 155 College St. has awarded contracts for 3 story 100 x 276 ft. collegiate school as follows: masonry to Britnell Contracting Co., Ltd., Baxter St., $224,720; steel, Dominion Bridge Co., Imperial Life Bldg., $19,178; carpentry, Hudson & Mosely, 61 Algonquin Ave., $58,000; stone, Geo. Oakley & Son, 278 Booth Ave., $86,490. Vacuum steam heating and mechanical ventilation contract not yet awarded. Noted Oct. 18, 1921.

Ont., Toronto—The city has awarded the contract for 4,000,000 gal. capacity centrifugal pump, electrically driven, to the John Ingles Co., 14 Strachan Ave., $10,791. Noted May 30.

Ont., Trenton—The Dominion Combing Mills, Ltd., A. E. Rea, 709 Continental Life Bldg., Toronto, has awarded the contract for a 1 and 2 story wool combing and washing plant. Estimated cost $200,000. Steam heating system will be installed.